Joliet Army Ammunition Plant
Wilmington, Illinois

Final
Five-Year Review Report
Groundwater Operable Unit

First Review Period
May 5, 1999 through May 4, 2004

Prepared for
U.S. Army Corps of Engineers
Louisville District
Louisville, Kentucky

Total Environmental Restoration Contract
DACW27-97-D-0015 Task Order 4014

April 2004

MWH

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MAY 0 6 2004

Mr. Arthur Holz
Commander's Representative
Joliet Army Ammunition Plant
29401 South Route 53
Wilmington, IL 60481-8879

REPLY TO THE ATTENTION OF S-6J

RE: Joliet Army Ammunition Plant (JOAAP) Five-Year Review Reports

Dear Mr. Holz:

The U.S. Environmental Protection Agency, Region 5 (USEPA) has reviewed the *Final Five-Year Review Report, Groundwater Operable Unit* and the *Final Five-Year Review Report, Soils Operable Unit*, dated April 2004, for JOAAP developed by MWH Americas, Inc. for the Army. These documents constitute the first five-year review for JOAAP.

USEPA concurs with Army's protectiveness determinations made for JOAAP. We also agree with the recommendations and follow-up actions suggested in the reports.

If you have any questions, please contact Diana Mally of my staff at (312) 886-7275.

Sincerely,

Richard C Karl

Richard C. Karl, Acting Director
Superfund Division

cc: N. Wilson, Illinois EPA
R. Walton, AEC
M. Thompson, USACE - Louisville
B. Evens, USACE - Louisville
K. Adams, MWH
R. Kwasneski, JADA
K. Minckler, USDA
B. Bowden, Joliet RAB

DEPARTMENT OF THE ARMY
JOLIET ARMY AMMUNITION PLANT
29401 S ROUTE 53
WILMINGTON IL 60481-5879

REPLY TO
ATTENTION OF
Site Manager

27 April 2004

Ms. Diana Mally
US Environmental Protection Agency
ATTN: SRF 5J
77 West Jackson Boulevard
Chicago, IL 60604-3590

SUBJECT: Five-year Review, Groundwater Operable Unit Final Report, Joliet Army Ammunition Plant (JOAAP), IL

1. Forwarded for your approval and acceptance is the subject report.

2. The point of contact is the undersigned at 815/423-2870.

Sincerely,

Arthur M. Holz
Site Manager

Encl
CF: w/encl
ILEPA (Ms. Wilson)
CELRL-DL-B (Ms. Thompson)
JOAAP RAB (Mr. Bowden)
SFIM-AEC-CDP (Mr. Walton)

DEPARTMENT OF THE ARMY
JOLIET ARMY AMMUNITION PLANT
29401 S ROUTE 53
WILMINGTON IL 60481-8879

REPLY TO
ATTENTION OF
Site Manager

27 April 2004

Ms. Nicole Wilson
Illinois Environmental Protection Agency
1021 North Grand Avenue East
PO Box 19276
Springfield, IL 62794-9276

SUBJECT: Five-year Review, Groundwater Operable Unit Final Report, Joliet Army Ammunition Plant (JOAAP), IL

1. Forwarded for your approval and acceptance is the subject report.

2. The point of contact is the undersigned at 815/423-2870.

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Encl
CF: w/encl
USEPA (Ms. Mally)
CELRL-DL-B (Ms. Thompson)
JOAAP RAB (Mr. Bowden)
SFIM-AEC-CDP (Mr. Walton)

MWH
MONTGOMERY WATSON HARZA

27 April 2004

Mr. Brooks Evens
U.S. Army Corps of Engineers
Louisville District
600 Martin Luther King Jr. Place
Attn: CELRL-ED-G-ER
Louisville, KY 40202-2230

Re: FINAL First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant (JOAAP)
Contract DACW27-97-D-0015, Task Order 4014

Dear Mr. Evens:

MWH Americas, Inc. is submitting the Final First Five-Year Review Report for the Groundwater Operable Unit at the Joliet Army Ammunition Plant (JOAAP). Copies of this report will be submitted to the parties identified in the distribution list including the Army, USACE, the U.S. Environmental Protection Agency (USEPA), and the Illinois Environmental Protection Agency (IEPA). Comments from USEPA and IEPA with responses are attached to this letter, which is bound into each report for documentation.

We appreciate the efforts by the Army, USACE, USEPA, and IEPA in producing and reviewing this report. If you have any comments or questions regarding the content of this report, please do not hesitate to contact me.

Sincerely,

MWH AMERICAS, INC.

Leo B Linnemanstons

Leo B. Linnemanstons
Groundwater Operable Unit Manager

Enclosures: FINAL First Five-Year Review Report (1)

cc: OSC - Art Holz (3)
USEPA - Diane Mally (2)
TechLaw - Terry Uecker (1)
Illinois EPA - Nicole Wilson (2)
USACE LRL - Melody Thompson (1)
USACE LRL - Don Peterson (1)
USACE LRL – Bill Gerard (1)
JOAAP RAB - Robert Bowden (1)
AEC – Greg Mellema (1)
AEC – Walton (1)

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Joliet Field Office
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Wilmington, Illinois
60481

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RESPONSE TO ILLINOIS ENVIRONMENTAL PROTECTION AGENCY COMMENTS
GROUNDWATER OPERABLE UNIT
DRAFT FINAL FIRST FIVE-YEAR REVIEW REPORT
JOLIET ARMY AMMUNITION PLANT

The following are written responses to comments provided by the Illinois Environmental Protection Agency (IEPA) on the Groundwater Operable Unit (GOU) Draft Final First Five-Year Review Report for the Joliet Army Ammunition Plant (JOAAP). Formal revisions to text sections are reflected in the GOU Final First Five-Year Review Report.

IEPA COMMENTS

Comments from Nicole Wilson, IEPA (April 5, 2004)

1. *Comment 9: Illinois EPA was looking for a reference to the Biotreatment Report which shows the results for the successfully treated SRU1 and SRU3 soils from M5. Please include the requested reference.*

   Response: Statements referencing the appropriate documents have been added to the text.

2. *Comment 18: Illinois EPA is not asking for a detailed site evaluation. The comment is just stating that the organizational format is not the same. Look at Section 7.4.1 for Site M3. There is a short site description then the Question A Subsection 7.4.1.1. The subsection contains the chemistry, geology, and hydrogeology type discussions and then identifies in bold the answer to Question A. For Site M10, Section 7.4.2, the chemistry, geology, and hydrogeology type discussions belong before the bolded text in Section 7.4.2.1.*

   Response: Section 7.4.2 will be reorganized to match the other sections as described in the comment.

3. *Page 3, Five-Year Review Summary Form:*

   a. *The new sedimentation basin is located in site M5 not M13. Please revise the text.*

      Response: Text will be revised.

b. *Please include a follow up action for site M13.*

Response: This modification will be added in the summary form and Section 9.

c. *Please remove the text relating to sampling discontinuation. Illinois EPA would like the opportunity to reevaluate the well data after the two sampling events have occurred.*

Response: The statement will be revised to read "the need for further sampling should be evaluated."

d. *The sedimentation basin is the new surface water compliance point for the site since development activities have altered the flow of surface water. This surface water location is to be sampled until all parties agree that the groundwater & surface water RGs have been met and site M5 is closed.*

Response: This text will be added in the summary form and Section 9. Because surface water sample location SWTET no longer receives surface water from Site M5 due to redevelopment of the area surrounding Site M5, sampling at SWTET should be discontinued at its present location. Because surface water now runs to a large sedimentation basin southwest of the site, sampling of the sedimentation basin should be conducted for explosives as the new surface water sample location SWTET. This surface water location is to be sampled until groundwater and surface water RGs for explosives have been met and site M5 is closed.

4. *Table 7-10:*

a. *Site M5 is listed on this table as being owned by the State of Illinois, site M5 is actually privately owned. Please revise accordingly.*

Response: The table will be revised to indicate that Site M5 is currently owned by Centerpoint.

b. *The text states that the property occupier submits a certification of compliance for institutional controls annually to the Army. Have these submissions actually been occurring? Please add a column to Table 7-10 that identifies if the property owners have actually been submitting the information. Please include copies of the letters.*

Response: In accordance with the documents that transferred industrial property with restrictions and covenants, the current land owner submits an annual letter attesting that no violations of same have occurred. This letter is written to the Army, but also distributed to the USEPA and IEPA. A copy of the most recent report is attached to demonstrate that the reports are received. The report often covers subject matter not related to the restrictions, as well. These have been blackened from the enclosed example.

This explanation will be added to the report in Section 6.5 – Site Inspection, and a column will be added to Table 7-10 to identify the properties for which the letter pertains. In addition, a copy of the letter will be added in Appendix J of the report.

RESPONSE TO ILLINOIS ENVIRONMENTAL PROTECTION AGENCY COMMENTS
GROUNDWATER OPERABLE UNIT
DRAFT FIRST FIVE-YEAR REVIEW REPORT
JOLIET ARMY AMMUNITION PLANT

The following are written responses to comments provided by the Illinois Environmental Protection Agency (IEPA) on the Groundwater Operable Unit (GOU) Draft First Five-Year Review Report for the Joliet Army Ammunition Plant (JOAAP). Formal revisions to text sections are reflected in the GOU Draft Final First Five-Year Review Report.

IEPA COMMENTS

Comments from Nicole Wilson, IEPA (February 25, 2004)

1. *Page ES-1: The first paragraph states that construction activities were the trigger for the five-year review. Remedial Actions (RA) are the trigger for five-year reviews. Please revise accordingly.*

   Response: The text has been changed to reflect RA construction activities conducted at Site M4 on May 5, 1999 as the trigger date for the first five-year review.

2. *Page 2, Five Year Review Summary Form and Page 8-1: The word "row" should be deleted and the sentence should simply read as follows: "Surface water now runs to a large sediment basin southwest of the site due to redevelopment of the area surrounding Site M5."*

   Response: The word row has been removed from the sentence in the report text.

3. *Page 2-1, Section 2.0: The Site Chronology for the groundwater and the soil operable units do not include the same events. Please compare to Section 2.0 from the soil operable unit (SOU) report and revise accordingly.*

   Response: The Site Chronology has been changed revised to match the SOU report.

4. *Page 3-7, Section 3.1.4: The second to last paragraph in the section states the facility-use contract between the Army and Alliant Techsystems, Inc. is still currently*

in use. Illinois EPA was under the assumption that this contract is no longer in use. Please check the status of this contract with the Army and revise as needed.

Response: The text has been changed to reflect that the contract between the Army and Alliant Techsystems, Inc. ended in 1999 and that site demobilization occurred during 2000.

5. *Page 3-8, Section 3.1.5: Please include discussion on the Management Group Agreement that was signed in August 2003.*

   Response: From the meeting held on March 4, 2004 at the JOAAP field office between USACE, IEPA, USEPA, Army, and MWH, a statement referencing the submittal of the February 2004 Proposed Plan for interim sites, and the Final ROD to be submitted during fiscal year 2004, has been included in the text.

6. *Page 3-9, Section 3.2.1: The text states that the plume does not extend into the upper bedrock aquifer for L14, however, the Exceedances of RGs for Groundwater in GRU1 table on this same page states the bedrock aquifer is affected. Please revise the table.*

   Response: The table for GRU1 groundwater has been revised.

7. *Page 3-14, Section 3.2.2: The first paragraph refers to Figure 3-7 for sites M1, M5, M6, and M7. M1 is not on this figure. Please revise the figure reference.*

   Response: The text has been changed to refer to Figure 7-41 for Site M1 and Figure 7-45 for Sites M5, M6, M7, M8, and M13. Figures 3-3 through 3-9 were removed from the report based on comments from the United States Environmental Protection Agency (USEPA). Water table maps have been renamed as Site Features/Water Table Map except for Site M3 where the bedrock potentiometric surface map was renamed.

8. *Page 3-16, Section 3.2.2.1: Please delete the extra period at the end of the last sentence on the page. ("The ESD modification was approved as proposed..")*

   Response: The text has been revised.

9. <u>*Page 3-18, Section 3.2.2.2:*</u> *Please include a reference to the report containing the soil results in the third paragraph on this page.*

   Response: We believe you mean the groundwater results reference in the third paragraph on page 3-18. A reference to Appendix C – Historical Groundwater Analytical Results has been added.

10. <u>*Page 3-20, Section 3.2.2.3:*</u>

    a. *The first full paragraph on the page states that the United States Army Corps of Engineers (USACE) developed a characterization plan in 2002 to locate other areas in Site M6 that require attention. Please verify with USACE that this date is correct. Illinois EPA believes this effort at M6 occurred in 2003.*

    Response: The text has been changed to reflect that the USACE developed a characterization plan in 2003, not 2002, to locate other areas in Site M6 that required additional attention.

    b. *The second full paragraph on the page uses the units of tons for soil amounts. Until this point the document has been using cubic yards. Please change to units of cubic yards or include cubic yards in addition to the tons. Also, check the rest of the document for similar situation.*

    Response: Where there is a reference to volume in cubic yards, the equivalent in weight (tons) has been include in parentheses. A 1.3 tons per cubic yard conversion was used.

11. <u>*Page 3-22, Section 3.2.2.5:*</u> *Site M8 has undergone liquidation activities to remove the raw sulfur from the surface soils, however this activity is not described here. The text states Site M8 was transferred in August 2000, but then goes on to state the Finding of Suitability to Transfer (FOST) was dated April 2002. Please revise the text in this section to clarify the discussion surrounding the site transfer.*

    Response: The text has been changed to reflect that the FOST for Site M8 was dated February 1999.

12. <u>*Page 3-23, Section 3.2.2.6:*</u> *Please include what kind of landfill cap will be installed at M13, i.e. Subtitle D, in the last paragraph of the section.*

Response: The text has been changes to reflect that the landfill cap to be installed at Site M13 complies with Subtitle D requirements.

13. Page 3-24, Section 3.2.3.1: *Please delete the extra period at the end of the second to last sentence on the page. ("Based on the non-intrusive nature of flashing operations, the vertical extent of lead is assumed to be limited to one foot..")*

    Response: The text has been revised.

14. Page 4-1, Section 4.0: *The last paragraph states the ROD selected final remedies for the SOU and GOU. Please include discussion on the interim portion of the ROD.*

    Response: The paragraph has been revised to read:

    The ROD presented selected final remedies for the SOU and GOU. Appropriate final remedial actions for future USDA soils have been developed, evaluated, selected, and presented in the *Proposed Plan for the Soil Operable Unit, Interim ROD Sites* (U.S.Army, February 2004). The selected remedies for interim sites will be formerly presented and approved by the appropriate regulatory agencies in accordance with the NCP, once the Final ROD for interim sites has been submitted. The submittal date for the Final ROD for interim sites is expected to be during fiscal year 2004. Site specific information describing remedy implementation, system operations, and O&M are described in detail in further subsections.

15. Page 4-1, Section 4.1: *Please include discussion on the Management Group Agreement.*

    Response: From the meeting held on March 4, 2004 at the JOAAP field office between USACE, IEPA, USEPA, Army, and MWH, a statement referencing the submittal of the February 2004 Proposed Plan for interim sites, and the Final ROD to be submitted during fiscal year 2004, has been included in the text. See response to IEPA-5.

16. Page 6-2, Section 6.4.1: *Please delete the extra period in the last paragraph on the page. ("If more than one well was available at a site for trend analysis, wells were preferentially selected where RG exceedances were the greatest..")*

    Response: The text has been revised.

17. <u>Page 6-5, Section 6.5:</u> *For transferred property, the 5-year review should have included some form of assurance whether by inspection and/or conversations with the current land users that the institutional* controls (ICs) placed on the properties are being followed.

Response: Table 7-10 has been added to the text which summarizes, current ownership, intended land use, status of deed restrictions, type of institutional controls, GMZ boundary figure reference, and frequency of monitoring at each site. Interviews were not conducted with current landowners or managers of transferred properties given the schedule on the First Five-Year review. This data gap has been identified as an issue in Section 8 and a recommendation to conduct interviews has been added to Section 9.

18. <u>Page 7-40, Section 7.4.2:</u> *The formatting for Questions A, B, and C for M10 is different than the other sites. Please revise to be consistent with the other sites.*

Response: The format for Site M10 is the same. A detailed site evaluation under Question A was not necessary because the site was granted closure during March 2003.

19. <u>Pages 9-1 to 9-8, Section 9:</u> *The 5-Year Review is meant to evaluate the protectiveness of the selected remedy and recommend solutions to overcome any shortcomings in protectiveness. This section proposes changes to the Long-Term Monitoring (LTM) Program that do not deal with improving the protectiveness of the remedy. While this kind of LTM evaluation is warranted, with an expedited review schedule for the 5-Year Review, Illinois EPA requests recommendations that are not necessary to improve protectiveness be removed and the text revised as needed. All parties can meet at a later date for an interactive meeting to discuss any proposed changes to the LTM plan on a site-by-site basis.*

Response: As discussed during the March 4, 2004 meeting at the JOAAP field office with USEPA, IEPA, Army, USACE, and MWH, recommendations for proposed changes to the LTM Program have been removed from the document.

20. <u>Page 9-5, Section 9.2.1:</u> *This section states "Section 9.2.3.2 of the ROD required wells at Site M1 sampled semiannually for the first five years and annually for the remainder of the monitoring program." However, upon viewing Section 9.2.3.2 of the ROD the above sentence applies to explosives and metals not sulfate. Page 6 of the ESD for M1 states semi-annual sulfate sampling will continue for the seven new* *wells, surface water locations, and original monitoring wells. Illinois EPA does not agree with the recommendation for M1and requests the sampling remain semi-annual.*

Response: Language regarding LTM Program changes at Site M1 have been removed. However, the comment is noted for future reference.

21.0 *Table 9-9:*

a. *The table identifies one of the in-plume wells to be MW323. Figure 3-7 has a MW323R labeled in Site M8. Illinois EPA assumes MW323R is the correct name. Please revise as needed.*

Response: References to proposed LTM Program changes have been removed from the document. However, the comment is noted for future reference.

b. *Illinois EPA is not agreeing or disagreeing with the recommendation, but merely stating that footnote (5) recommends discontinuing volatiles and explosives, but MW327R, which is identified with the footnote, has only volatiles listed as sampling parameters. Is the footnote or well description correct?*

Response: References to proposed LTM Program changes have been removed from the document. However, the comment is noted for future reference.

22. *Table C-1: What does "D" mean? It is not listed in the footnotes.*

Response: Table C-1 has had a footnote added to reflect that D means the compound was reported from a diluted analysis.

RESPONSE TO ENVIRONMENTAL PROTECTION AGENCY COMMENTS GROUNDWATER OPERABLE UNIT DRAFT FINAL FIRST FIVE-YEAR REVIEW REPORT JOLIET ARMY AMMUNITION PLANT

The following are written responses to comments provided by the Environmental Protection Agency (EPA) on the Groundwater Operable Unit Draft Final First Five-Year Review Report for the Joliet Army Ammunition Plant. Formal revisions to text sections are reflected in the Groundwater Operable Unit Final First Five-Year Review Report.

EPA COMMENTS

Comments from Diana Mally, EPA (April 9, 2004)

1. *The response to previous USEPA comment number #13 stated it is evident that sulfate occurs in groundwater in the vicinity of JOAAP at levels greater than the remedial goal (RG) of 400 mg/L. USEPA would like to discuss the issue of elevated sulfate concentrations in groundwater in more detail at a later date. Since the groundwater RG for sulfate is based in part on protection of surface water quality, sampling for sulfate in surface water at the GMZ boundary may be warranted in the future.*

   Response: Comment noted.

2. *USEPA agrees the BIOSCREEN model input parameters do not need to be re-evaluated at this time. We suggest the input parameters be evaluated in the future and that the BIOSCREEN predictions be calibrated with measured field data for more accurate results.*

   Response: Comment noted.

3. *Page 3, paragraph after bullets, last sentence - Please specify the site at which sedimentation sampling for explosives is being proposed.*

   Response: The statement will be modified to specify that surface water sampling will occur at the new sedimentation basin at Site M5.

4. *Page 1-1, paragraph 2 - Identify the Army as the lead agency conducting the review.*

   Response: A statement will be added identifying the Army as the lead agency.

5. *Page 3-8, paragraph 1 - Modify the third sentence to state, "Risks and hazards . . . used for potable water supply using a commercial/industrial exposure scenario."*

   Response: The statement will be modified.

6. *Sections 3.2.1.1, 3.2.1.2, 3.2.1.3, 3.1.2.4 (typo for section number), 3.2.2.1, and 3.2.3.1 for Sites L1, L2, L3, L14, M1, and M3 - Modify the last paragraph in each sentence to state, "Site XX (L1, L2, L3, L14, M1, M3) is not located near a heavily populated area. The future land use for Site XX is intended for development into the USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soils and groundwater at the site were stated to pose an unacceptable hazard to future recreational users. Final groundwater RGs were established in the ROD. Once final soil RGs are designated for the USDA lands, remedial action activities will be conducted to clean up contaminated soil. Remedial action activities are scheduled to occur during fiscal year XXXX (put in appropriate year)."*

   Response: The paragraphs referenced in the comment will be modified as suggested.

7. *Sections 3.2.2.3, 3.2.2.4, and 3.2.2.6 for Sites M6, M7, and M13 - Modify the sentence that states risk-based models have been based on RGs to state, "Based upon future industrial use of Site XX (M6, M7, M13), final soil RGs established in the ROD were based on human health risk-based models for industrial exposure."*

   Response: The paragraphs referenced in the comment will be modified as suggested.

8. *Page 3-27, paragraph 3 - Modify the last two sentences in this paragraph to be consistent with language suggested in the above comments.*

   Response: The paragraph referenced in the comment will be modified as suggested.

9. *Page 9-1, paragraph after bullets, last sentence - Please specify the site at which sedimentation sampling for explosives is being proposed.*

   Response: The statement will be modified to specify that surface water sampling will occur at the new sedimentation basin at Site M5.

RESPONSE TO ENVIRONMENTAL PROTECTION AGENCY COMMENTS GROUNDWATER OPERABLE UNIT DRAFT FIRST FIVE-YEAR REVIEW REPORT JOLIET ARMY AMMUNITION PLANT

The following are written responses to comments provided by the Environmental Protection Agency (EPA) on the Groundwater Operable Unit Draft First Five-Year Review Report for the Joliet Army Ammunition Plant. Formal revisions to text sections are reflected in the Groundwater Operable Unit Draft Final First Five-Year Review Report.

EPA COMMENTS

Comments from Diana Mally, EPA (March 8, 2004)

1. *One of the components of the selected remedy for groundwater is the implementation of institutional controls. The report should clearly indicate the specific access controls (e.g., fencing, security guards) and institutional controls (e.g., zoning, deed restrictions) that are needed and are in place for this phase of the cleanup. Modify the report to include the access controls and institutional controls that pertain to each site, the ownership of each site, the status of the institutional controls at each site, and a description of how the controls are being monitored and maintained at each site. This information could be provided in a table and briefly discussed in the text.*

   Response: Table 7-10 has been added to the report. In addition to items requested, figure references depicting GMZ boundaries and frequency of monitoring conducted at each site were also included in the table.

2. *The presentation of contaminant data does not include any maps of the groundwater plumes present. Revise the report to include appropriate maps depicting plumes or relative contaminant concentrations.*

   Response: Extent of plume maps have been prepared for all sites except M3 and M10. Site M10 has been closed and Site M3 has had no detections for VOCs since 1991 therefore, there is no plume to illustrate. Since sulfate is a naturally occurring anion, the contaminant map for Site M1 (Figure 7-41) represents the extent of sulfate RG (500 mg/L) exceedances in groundwater.

3. *Once source removal actions are complete for each groundwater management zone (GMZ), the natural attenuation demonstration should present isoconcentration maps*

of the contaminants, electron acceptors, and metabolic byproducts if applicable. The spatial distribution of these parameters provides valuable information on potential biodegradation processes at the sites. It is also useful to plot loss of contaminant mass in the downgradient direction by using plots, which show contaminant concentrations versus distance downgradient of several wells along the groundwater flow path over several sampling events.

Response: It is our understanding that this request applies when remedial action activities have been completed and does not apply to the First Five-Year Review. No revisions made or recommended for the next Five-Year Review.

4. *Currently the report provides cleanup times for specific contaminants of concern (COCs) in specific wells at each site, but does not provide an overall cleanup time frame for all of the COCs at a site. Cleanup time frames need to be developed for each site considering all of the contaminants at each site. If cleanup time frames are unreasonably long compared to active remediation, then contingency remediation plans would need to be implemented.*

   Response: Table 6-1 has been modified to include a comparison of clean-up times predicted in the ROD and those calculated for the First Five-Year Review Report using trend plot data. While still predicting clean-up times for individual COCs, Table 6-1 has the longest estimated clean-up time for a particular COC at a site bolded. The bolded value represents the overall cleanup time frame for a particular site. Contaminated soil removal should decrease contaminant loading to the groundwater likely resulting in shorter estimated clean-up times.

5. *Revise the report to include estimated timeframes for all future remedial action activities for the Soil Operable Unit (SOU), since source control is a component of the groundwater natural attenuation remedy.*

   Response: Estimated dates for SOU RA activities have been added to the end of each site history in Section 3 and have been included as a separate column in Table 6-1. In addition, a statement referencing SOU RA activities has been added to the answer to Question A for sites where it was applicable.

6. *The report states in several places that soil remedial goals (RGs) need to be established before final remediation of the USDA lands can be undertaken. Include in the report information about the stage of development for these RGs or when they are expected to be determined.*

Response: The second to last paragraph in Section 3.1.5 has been changed to reflect that appropriate final remedies for future USDA soils have been developed, evaluated, selected and presented in the *Proposed Plan for the Soil Operable Unit, Interim ROD Sites* (U.S. Army, February 2004). The selected remedies for interim sites will be formerly presented and approved by the appropriate regulatory agencies in accordance with the NCP, once the Final ROD for interim sites has been submitted. The Final ROD for interim sites is expected to be during fiscal year 2004.

7. *The Data Review process discussed in Section 6.4 identifies four distinct review methodologies that have been used to assess groundwater monitoring data. The groundwater monitoring program was initiated in 1998 with a baseline event and since that time semi-annual monitoring has been conducted. Although a review of each of the methodologies is provided, no discussion is provided regarding how the collective results of these review methodologies will be interpreted. Provide additional discussion regarding the decision process for this overall interpretation and a comprehensive evaluation of natural attenuation at each site. At a minimum, address the following issues: 1) Data from different time periods are used for different evaluations. Clarify why this decision was made, and how it affects the interpretation of results. Particularly address the use of data before 1998 for some evaluations, and; 2) Since more than one technique is used to evaluate water quality trends, clarify the decision process when different techniques represent conflicting trends (e.g., no trend or insufficient information vs calculation of cleanup times). These conflicts occur and are discussed in Section 7.0, but no information is provided regarding why conclusions that the remedy is functioning as intended are appropriate. For example, for well MW307, the Mann-Kendall test for TNT resulted in an undetermined stable trend. The curve-fitting evaluation estimated 2000 as a clean up date, but TNT exceeded the RG in 2003.*

Response: Because of specifications in the GOU RD/RA Workplan (Montgomery Watson, 1998) and requirements in the ROD, BIOSCREEN modeling, first order rate decay determinations, and trend analysis were used. The ROD required that a groundwater model be developed to determine if GMZs assigned to GOU sites would be appropriate. The BIOSCREEN model was chosen at the RD/RA Workplan preparation stage. The ROD also called for using site analytical data to predict estimated clean-up times for GOU sites. Plotting site data and applying exponential curve fitting is a standard method to calculate first-order rate decay constants and predict estimated clean-up times. The Five-Year review process usually is applicable to sites in which SOU RA activities have been completed, but SOU RA activities have only been conducted at three of the ten (M5, M6, and M7) GOU sites proposed for source removal and one of the three (M6) is ongoing. Nonetheless, data was analyzed for all GOU sites in a good faith attempt to determine if the chosen remedy is effective at the each GOU site. The chosen remedy of monitored natural attenuation (MNA) is considered to be functioning as designed in the ROD as long as contaminant concentrations in groundwater are not exceeding RGs at points of compliance for site GMZs and institutional controls prohibit the withdrawl and consumption of contaminated groundwater.

Because soil source control measures have not been conducted at all the GOU sites, conflicting results from analytical tools may be expected to occur. Source loading to groundwater is not constant and may vary due to site conditions. Large recharge events or soil disturbances may trigger a spike in concentrations. Curve fitting data scattered by such influences causes R^2 values to decrease because of the variability. The use of historic data for trend analysis and first order decay rate determinations is warranted as discussed in our response to EPA-8. For all sites except M5 and M7, contaminant concentrations have decreased from historic levels due to contaminant half-life and bioattenuation and physical mechanisms, not remedial activities (RA). In order to calculate first order decay rates reflective of actual site conditions (effective decay rate), all site data available was plotted and certain outliers based on professional judgement were excluded. Clean-up times calculated from trend analyses that have exponential curves with R^2 values closer to zero than one will likely be less reliable. More reliable estimates of first order decay rate constants and predicted clean-up times will be accomplished when soil source control measures have been implemented. Excluding pre-RA data may be justified at that point to alleviate problems associated with non-linear soil source loading to groundwater.

The BIOSCREEN model is being used to predict the distance the plume will extend from the source areas at each site. The BIOSCREEN model was run using the greatest known contaminant concentration at a particular site regardless of when it occurred. Additional conservative inputs included source half-life set at infinite even though SOU RA activities have and/or are scheduled to occur over the next four years, no retardation factors were applied despite favorable site conditions for retardation, and first order rate decay constants used were lower than those publicized. Using these extremely conservative assumptions for model inputs has likely predicted distances of RG exceedances much further from the source than what sampling results have actually shown them to be.

The Mann-Kendall test was added because it is a statistical tool to determine concentration trends at a site. As with the other methods used to analyze the data at the GOU sites, this test will be affected by the status of source control measures at a particular site. As noted above, only two of ten GOU sites have had SOU source control measures completed. The Mann-Kendall test was set-up to analyze the ten most recent sampling events in a regularly spaced time series assuming no seasonal variation. This requirement precluded the use of historic data before baseline sampling occurred in 1998. In addition, the test did reveal increasing trends for some contaminants at monitoring wells at Site M6 (the site reference in the comment). It was anticipated that when soil source areas are disturbed and excavation occurs down to the water table surface that spikes in groundwater concentrations of contaminants would occur.

Additional explanation has been added to the text of the report in Section 6.4.

8. *For cleanup time calculations, the data were fit to an exponential curve to represent first order decay. The appropriateness of applying an exponential curve to the data set seems to be highly dependent on considering historic data. If only data collected since 1998 are considered, the appropriateness of this curve model is questionable. Discuss why this exponential model is appropriate and why the use of historic data are appropriate. Additionally, discuss if and how the calculated cleanup times may change if only data since 1998 are considered. It is not clear if different predictive models would be used for this more recent data set. If the use of exponential models is considered to be appropriate, discuss if the concentrations appear to be approaching an asymptotic concentration and how this situation will be addressed in the modeling (the equation for the curve fitting would need to be modified).*

Response: MWH believes the exponential model is the appropriate curve model to use to assess groundwater quality data at sites relying on biological degradation for MNA several reasons. First, the exponential model (y=exp(x)) is the typical governing equation describing first-order biological degradation (C/C0 = exp(-kt)) and is the model used by most contaminant transport models to describe the biological degradation component of the transport equation (EPA, 2002, Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies. EPA/540/S-02/500). Therefore, extrapolating what the concentrations will be in the future should use a model that describes the processes occurring in the field.

The exponential model fit reasonably well with the historic data on sites where there had not been recent soil excavation remedial action. This includes wells monitoring areas L2, L3, L14, M13. Although the correlation coefficients for these curve matches are relatively low (e.g., they are less than $R^2 = 0.5$), the downward trend is apparent and, while variation in the data exists, these locations are generally following a first-order decay equation. Extrapolating concentration trends forward in time from highly variable noisy data, regardless of the curve model selected, results in some degree of uncertainty that can not be avoided. Therefore, while the degree of confidence on the future projections is limited by the data variability to date, the projection uses a model that describes the processes occuring at the sites (first-order biological decay) and a decay rate based on a fit to historical data. If the data in the future deviate from this general trend, then the model will help identify what sites or locations are not performing as expected and where some additional assessment or corrective action should be considered.

At locations where soil excavation had recently occurred (areas M6 and M7) the subsequent groundwater quality data did not exhibit a downward trend. Rather, at some of these locations the groundwater concentrations have increased, potentially in response to higher groundwater recharge rates and either mobilization of constituents within the soil being excavated or mobilization of adsorbed constituents due to changes in groundwater chemistry or groundwater elevations. Therefore, the conceptual model of biodegradation from a constant source area is not appropriate for these areas. This is consistent with the resulting decay rates calculated for areas M6 and M7. The resulting decay rates are either very low (2e-6/day at MW212, 1e-5/day at MW315) or negative decay rates which indicate increasing concentrations (e.g., at MW124R). Because a negative decay rate was determined at MW124R at Site M7, no first order rate decay constant was calculated and no first order rate decay constant was used in BIOSCREEN modeling for Site M7.

Additional explanation has been added to the text of the report in Section 6.4 and elsewhere.

8. *(continued) Additionally, discuss if and how the calculated cleanup times may change if only data since 1998 are considered. It is not clear if different predictive models would be used for this more recent data set.*

Response: We would not recommend different predictive models for post 1998 data for many of the same reasons described above. Particularly, we believe that natural biodegradation should be following a first-order decay curve and that substantial deviations from this curve need to be explained in terms of the conceptual model (e.g., remedial actions that may have affected the concentration profile, some exceedance of the biological degradation capacity, etc.). The effect of deleting pre-1998 data from the analysis does not substantially affect the computed decay curves at wells showing concentration declines.

Well	Complete Data decay rate (1/day)	Pre 1998 decay rate (1/day)
L2-MW404	0.0003	0.0005
L3-MW412	0.0004	0.0004
L14-MW508	0.0008	0.0007
M13-MW321	0.0002	0.0003

8. *(continued) If the use of exponential models is considered to be appropriate, discuss if the concentrations appear to be approaching an asymptotic concentration and how this situation will be addressed in the modeling (the equation for the curve fitting would need to be modified).*

Response: The concentrations do not appear to be approaching an asymptotic concentration. For instance, we will use the figure in Appendix E for RDX at MW404 at Site L2. While the concentration decline appears to be slowing down at wells like MW404, this is readily explained using the first-order biological decay model. As the concentrations get lower, the apparent rate of concentration decline is slowed as viewed on a linear scale. However, as shown in the figure (graph) for well L2-MW404, when plotted on a log scale, the rate of decline appears to be proceeding according to the first-order decay equation. If, in the future, the rate of decay slows down or the concentrations begin to reach an asymptotic concentration, future reviews of the measured decay rate or plots of concentration through time should illustrate these conditions. This comment raises a significant point that the time concentration graphs should probably be presented on a log concentration scale. However, these types of presentations, while technically more accurate, are not as easily understood by the public. Therefore, we presented the graphs on a linear concentration scale.

9. *Although a general statement is made that R^2 values that approach zero represent a poor fit of the data, no discussion is provided regarding if and how the models resulting from these poorly fit data are used. Specifically, discuss the uncertainties of predictions of cleanup times that are provided for data sets with very low R^2 values, i.e., poor fits.*

Response: Clean-up times calculated from trend analyses that have exponential curves with R^2 values closer to zero than one will likely be less reliable. Plotting site data and applying best-fit exponential curve is a standard way to calculate first-order rate decay constants and predict estimated clean-up times. More reliable estimates of first order decay rate constants and predicted clean-up times will be accomplished when soil source control measures have been implemented at each site. Once soil source controls measures are completed, non-linear loading to groundwater should cease and groundwater concentrations will become less variable. Curve fitting less variable data will produce R^2 values closer to one (perfect fit). Estimated clean-up times should become more reliable one data variability decreases.

Additional explanation has been added to the text of the report in Section 6.4.

10. *The Mann-Kendall analysis appears to only include data collected since 1999; it is unclear why the baseline data collected in 1998 was not included (see Appendix F). The Wisconsin Department of Natural Resources (WDNR) spreadsheet was used to determine if a trend was evident at the 80% confidence level. It appears that the WDNR spreadsheet has been altered particularly as related to the classification of un-determined trends. Specifically, it is not appropriate to indicate that a trend is stable at the 80% confidence level using a Coefficient of Variation Test. This test*

does not include any significance testing; rather it is a simple calculation to represent data set variability. As a result, it is inappropriate to imply a confidence associated with undeterminable (stable) trends.

Response: Please note that the Mann-Kendall and BIOSCREEN spreadsheets used during evaluation of groundwater analytical data for the First Five-Year Review Report for the Joliet Army Ammunition Plant were **not** altered with regard to their function, and they were used as downloaded from the WDNR and USEPA websites, respectively. As to the observation noted in the above comment, the 1999 version of the WDNR Mann-Kendall spreadsheet was inadvertently used for the First Five-Review analysis. Consequently, all Mann-Kendall analyses were redone using the most recent version (February 2001) and are presented in Appendix F. All references to confidence interval associated with undetermined, stable trends have been removed from the text. Results using the February 2001 version are the same as the 1999 version except trend determination is reported at both 80% and 90% confidence intervals. If no trend exists at an 80% confidence level, a stability determination is made based on the coefficient of variation (CV). If the CV is ≤ 1, a stable plume determination is made. If the CV is >1, a non-stable plume determination is made.

11. *The Mann-Kendall analysis was applied to "wells exhibiting the highest concentration at each site" (page 6-4). It is unclear that this evaluation is necessarily conservative. In cases where the well with the highest concentrations was used, it is not surprising that the concentrations have dropped. Wells that may be of more concern are those that started at lower concentrations, which may have leveled off or may actually be increasing. Further discussion about the selection of wells evaluated should be provided.*

    Response: The use of the Mann-Kendall analysis on wells with the highest concentrations was not implied to be the most conservative approach. However, because the majority of contaminant mass at a site is associated with wells exhibiting the highest concentrations, the trends exhibited by these well may provide a valuable indication to what is happening near the contaminant sources at each site given the stage of remediation (First Five-Year Review). Decreasing trends near a source that has yet to be actively addressed may not be surprising, but the result indicates the likelihood that natural attenuation is occurring. Similarly, increasing trends at wells near sources that are currently being removed is also expected as discussed in previous responses. The use of the Mann-Kendall test was limited to the same wells used in the other analyses for consistency in reporting results. Additional explanation has been added to the text of the report in Section 6.4.

12. *The BIOSCREEN calculations presented in Appendix G are extremely sensitive to the dispersion input values, and there are concerns with the actual values used in the*

simulations. To demonstrate the sensitivity of the dispersion values, the contaminant advective flow at Site M6, monitoring well MW212R should be considered. Based on the hydraulic conductivity, hydraulic gradient, and porosity values of 8.9E-04 cm/sec, 0.027 ft/ft, and 35.6%, the calculated groundwater velocity in the vicinity of this well is 69.8 ft/yr. The decay rate from the long term monitoring data is reported at 0.0011 per year (half-life of 630 years). If the contaminant flow were considered without the influences of retardation and dispersion, the contaminant concentrations would theoretically be 2,300 ug/l in 630 years (one half-life), at an advective distance of 43,998 feet. However, the concentration shown on the BIOSCREEN printout at 900 feet is 4.0 ug/l. Since no retardation was assumed in the BIOSCREEN runs (R=1), these differences indicate the sensitivity of the dispersion input parameters. Other specific examples dispersion parameter sensitivity are provided in comments on Appendix G below. While it is acknowledged that dispersion is a factor that should be considered in the modeling simulations, it is critical that the sensitivity of this value be adequately evaluated. The dispersion input values used in the BIOSCREEN model runs should be re-evaluated. As a result of the extreme sensitivity of dispersion on the model output, it is imperative that the BIOSCREEN predictions be calibrated to measured field data, using dispersion as the calibration parameter, where sufficient field data are available.

Response: We agree that the BIOSCREEN model is sensitive to the dispersivity values, and the model would also be sensitive to hydraulic conductivity, retardation, and contaminant decay rate. Changing any one of these factors through a reasonable range of values could have a large effect on the travel distances calculated by the model. For the BIOSCREEN model runs in the five-year review report, we used the same input parameters as in the GOU RD/RA Workplan except for changing the first-order decay rate based on trend analyses conducted as part of the five-year review. The purpose was to evaluate the impact on the BIOSCREEN results by using these new first-order decay rates. We did not intend to revisit the determination of other site parameters from the GOU RD/RA Workplan. See also response to comment for EPA-63.

13. *The Groundwater Remedial Units (GRUs) established in the 1998 Record of Decision (ROD) did not account for RG exceedances of sulfate in several groundwater monitoring wells at several sites. Since the 1998 ROD, sulfate has been determined to be the primary contaminant of concern at Site M1, the southern ash pile. The five-year review should evaluate whether sulfate should be regularly sampled and analyzed for at other sites, including Site M9, the northern ash pile.*

Response: Combined well MW148RR (Site M6) and overburden wells MW166R, and MW330 (Site M8) exhibited sulfate RG exceedances during October 2003. Reported concentrations of sulfate were 460 mg/L, 460 mg/L, and 500 mg/L, respectively. While these monitoring wells are located downgradient of Site M9, concentrations of sulfate detected during October 2003 do not exceed background levels measured during the Phase II RI conducted by Dames and Moore, Inc. Background overburden well BMW1, located upgradient of Site M9 near Maple Hill Cemetery, had sulfate detected at a concentration of 500 mg/L. In fact, sulfate ranged from 48.2 to 15, 000 mg/L in the six background wells sampled during the Phase II RI. In addition, exceedances of the RG for sulfate also occurred at overburden well MW325R (Site M8) and combined well MW159 (Site M7). The reported concentrations for sulfate were 690 mg/L and 1,100 mg/L, respectively well within the range exhibited in background wells. It is evident that sulfate occurs in groundwater in the vicinity of JOAAP at levels greater than the RG (400 mg/L). The only site in which sulfate exceeds background levels is Site M1.

Site M9, the Northern Ash Pile, was constructed differently than Site M1, the Southern Ash Pile. Site M1 was constructed so that ash has now come into contact with groundwater due to subsidence. Ash at Site M9 was placed directly on the ground surface, not in contact with groundwater. Depth to groundwater at Site M1 ranged from approximately 1.5 to 7.8 ft below ground surface. Concentrations of sulfate are elevated at Site M1 because of direct dissolution of ash in groundwater. Site M9 had a temporary cover installed during 2001 which promotes run-off and limits infiltration of precipitation. In addition, depth to groundwater at Site M9 is greater than 20 ft. It should be noted that according to Table 6-4 of the ROD, Site M9 has been classified as a no further action (NFA) site.

Sulfate RG exceedances at sites other than Site M1 have not been added as an issue to Section 8 and no recommendation for further sampling has been added to Section 9.

14. *Remove all statements from the text that Sites L1, L2, L3, M1, M3, and M6 are not located near environmentally sensitive areas. All of these GOU sites discharge to surface water features (creeks and/or wetlands) which can be considered environmentally sensitive areas.*

    Response: The text has been revised removing the reference of environmentally sensitive areas for the referenced sites.

15. *The report should specify that surface water within a GMZ must meet the surface water quality criteria at the downstream boundary of the GMZ (point of compliance).*

    Response: The report has been revised to reflect that surface water within a GMZ must meet surface water criteria at the downstream boundary of the GMZ.

16. *Correct the five-year review trigger (start) date to May 5, 1999, when the construction of the soil stockpile area was initiated, throughout the report (text and tables).*

    Response: Text and tables have been changed to reflect that the start of construction of the soil stockpile area at Site M4 on May 5, 1999 is the trigger date for the five-year review process.

17. *USEPA does not concur with any of the proposed changes to the groundwater long-term monitoring (LTM) program at this time. Modify the report to remove all language stating changes have been made to the program (e.g., page 2). USEPA recommends the project team review, discuss, and agree to any changes in the LTM program, and that the revised, optimized LTM program becomes a revision to the RD/RA workplan and is incorporated into the LTM semi-annual reports.*

    Response: As discussed during the March 4, 2004 meeting at the JOAAP field office with USEPA, IEPA, Army, USACE, and MWH, references to modifying the LTM Program have been removed from the text except those covered in Section 8 (issues) and Section 9 (recommendations and follow-up actions).

18. *Several site features (lagoons, drainage ditches) are described in Section 3.2 and are not presented on site figures. While revisions to the site figures at this time are not required for purposes of the five-year review, current site figures should be updated for the interim ROD sites RD/RA workplan and for any optimization to the LTM program.*

    Response: It is understood that changes to figures will not be required for the First Five-Year Review Report but will be required for RD/RA Workplan Addenda. Any proposed LTM Program changes will be addressed in RD/RA Workplan Addenda and figures updated accordingly.

19. *Clarify in the text and tables that the "interim" actions taken at Sites M1, M9, and L3 were interim maintenance or O&M activities. See page 3-6, paragraph 4, as an example of text requiring clarification.*

    Response: Text and tables have been revised to reflect that "interim" actions at sites M1 and L3 were interim maintenance or O&M activities. Site M9 is not part of the GOU, therefore no mention of interim actions were made in the report.

20. *Revise the report to include the definition of a combination well and an explanation for an "R" at the end of a monitoring well label.*

    Response: Section 4.3, page 4-6 has been modified to explain that replacement wells are labeled using the original well name followed by a "R" which designates the well as a replacement well. The text has been revised to define a combination well as a well which is screened across overburden and bedrock stratigraphic units.

21. *Five-Year Review Summary Form, Page 2 - Remove the last sentences regarding the proposed LTM programs from the protectiveness statements.*

    Response: The last sentences regarding proposed LTM Program changes have been removed from the protectiveness statements.

22. *Five-Year Review Summary Form, Page 2, Protectiveness Statement for Site M10 - Include at the end of the 1st sentence, ". . . met and are protective of human health and the environment."*

    Response: The text has been added to the protectiveness statements in the Five-Year Review Summary Form and Section 10 (Protectiveness Statements).

23. *Page 2-5 - Clarify whether the ESD submitted in February 2003 was submitted for approval or was approved by Army, USEPA and IEPA.*

    Response: The text has been revised to reflect that the Approved ESD for Site M1 was submitted in February 2003.

24. *Page 2-5 - Clarify if the Site M10 Closure Report submitted in March 2003 was the final report or a draft report.*

    Response: The text has been revised to reflect that the Final Closure Report was submitted in March 2003.

25. *Page 3-7, paragraphs 1 and 2 - Update these paragraphs to describe current conditions (e.g, when Alliant left, past liquidation/demolition activities, and current decontamination activities being undertaken by Plexus).*

    Response: The text has been revised to reflect that the Alliant Techsystems, Inc. (ATK) not used JOAAP since 1999 and that Atkdemobilized from the site during

2000. In addition, the text was changed to reflect that Plexus Scientific Inc. (Plexus) is currently under contract with the U. S. Army to perform decontamination and demolition activities for building contaminated by historic activities at JOAAP. Plexus's first work was conducted at the continuous lines at Site M6 during January 2000 and they are working on LAP groups presently..

26. *Page 3-8, Section 3.1.5 - Since this section discusses the general basis for taking actions, please describe in more detail the exposure scenarios (e.g., future industrial use, future recreational use) under which unacceptable risks were determined for both soil and groundwater.*

Response: The following statement has been added to Section 3.1.5; "Sections 6.1 and 6.2 of the October 1998 ROD discuss in detail the exposure scenarios for human health and ecological risk assessment. These sections defined and determined the unacceptable risks for soil and groundwater".

27. *Sections 3.2.1, 3.2.2, and 3.2.3 - With the exception of the first two sentences, the last paragraph closing the specific discussion for each site under each GRU actually discusses remedy selection and implementation for the SOU. Remove the sentences discussing the remedy from these paragraphs.*

Response: References to SOU RA activities were not removed from the text. SOU RA activities are imperative to the success of the monitored natural attenuation remedy chosen for GOU sites of concern. SOU RA implementation dates have been added to the end of each paragraph to give the reader reference to when soil contaminant loading to groundwater can be expected to end at each site of concern.

28. *Page 3-16 - Replace the words "cap" and "capping" with "cover."*

Response: References of "cap" and "capping" have been replaced with "cover" in the text.

29. *Page 3-18, paragraph 6 - Risk models are not based on RGs. Revise the first sentence to state, "Based upon future industrial use of Site M5, final soil RGs established in the ROD were based on human health, risk-based models for industrial exposure."*

Response: The text has been revised to read "Based upon future industrial use of Site M5, final soil RGs established in the ROD were based on human health, risk-based models for industrial exposure."

30. *Page 3-20, paragraph 4 - The text states tetrachloroethene (PCE) was detected at 150 ug/L in one sample. The text does not identify the well that had the detection and the result is not included in Table C-2. Figure 3-7 does not show the former shop area, which is the suspected source. Revise the report to include all pertinent information related to this PCE detection and discuss the need for further VOC sampling in this area.*

    Response: The referenced detection of PCE could not be verified. Language used in the First Five-Year Review Report regarding the PCE detect at Site M6 was taken directly from the ROD. The database used to generate data tables (Table C-2) may not be inclusive. The location of the former shop could not be verified. Monitoring wells MW118, MW119, MW123, MW125, MW160, MW161, MW162, MW166/MW166R, MW307, MW308, MW309, MW311, MW312, MW313, MW314, MW315, MW316, MW317, MW319, MW320/MW320R, MW650, MW651, MW662, MW663, MW664, and MW665 (26 wells) at Site M6 have been sampled for VOCs during the RD/RA baseline sampling conducted in 1998 and/or during LTM activities conducted between 1999 and 2003. A total of 107 analyses of groundwater from Site M6 have been performed for VOCs. The only detection for PCE occurred at monitoring well MW313 during July 1998 at an estimated concentration of 2 ug/L. The detection was considered estimated because the value reported was less than the level of detection (LOD; 5 ug/L) but greater than the level of quantitation (LOQ; 1.0 ug/L). Subsequent resampling of monitoring well MW313 during December 1998 resulted in a non-detect for PCE. Based on the extensive amount of sampling of groundwater at Site M6 for VOCs between 1998 and 2003, we feel it is unlikely that a PCE plume exists at M6 and that the mentioned PCE detection may be an anomaly or was reported in error. Further sampling for PCE at Site M6 does not appear to be warranted.

31. *Page 3-20, paragraph 4 - An exceedance for cadmium in well MW123 is discussed. Based on Table C-3, no cadmium data have been collected in MW123 or MW123R. Make any necessary corrections. Discuss the need for additional metals sampling at this and surrounding wells if applicable.*

    Response: The detection for cadmium could not be verified. Language regarding the detection of cadmium at monitoring well MW123 during 1982 was taken directly from the ROD. The database used to generate data tables (Table C-3) may not be inclusive. Table C-3 indicates that cadmium was analyzed for a sample collected from monitoring well MW123 during June 1981. Cadmium was reported as a non-detect with an associated detection limit of 5.5 ug/L. There is no indication that MW123 was sampled for cadmium during 1982. Monitoring well MW123R will be sampled for dissolved cadmium during the Spring or Fall 2004 sampling event to determine if the cadmium detection was reported in error in the ROD or if the detect was an anomaly. If cadmium is detected above the RG (5 ug/L) at MW123, additional sampling will be done for cadmium in wells in the vicinity of MW123R (MW161, MW162R, and MW208). The cadmium detection has been added to Section 8 as an issue. Subsequent resampling of MW123 for cadmium has been added to Section 9 as a follow-up action.

32. *Page 3-20, last paragraph - Indicate in this paragraph that a portion of the site (M6 North) has already been transferred to the State of Illinois, and subsequently to a private developer.*

Response: Additional text has been added to Section 3.2.2.3 reflecting that the northern portion of Site M6 has already been transferred to the State of Illinois, and subsequently to a private developer.

33. *Page 3-23, paragraph 1 - Exceedances of antimony and cadmium are noted in this section. However, these exceedances are not shown on Table 9-1 or in Table C-3. Make any necessary corrections and discuss the need for additional metals sampling at this site if necessary.*

Response: Antimony was detected at 38.8 ug/L during October 1991 at monitoring well MW322. Subsequent resampling of monitoring well MW322 during July 1998 indicated a non-detect for antimony at a reporting limit of 5 ug/L. The referenced detection of cadmium at 56 ug/L could not be verified. The database used to generate data Table C-3 may not be inclusive. Monitoring well MW126 was sampled for cadmium during May 1981, September 1991, and July 1998. Cadmium was not detected in any of these analyses. Language regarding the cadmium detection at MW126 was taken directly from the ROD. It is unclear whether the ROD reference is incorrect or an anomaly. Since subsequent resampling for cadmium at MW126 took place during July 1998 and there was no detection for cadmium, resampling is not necessary. Additional explanation has been added to the text of the report.

34. *Page 3-25, paragraph 2 - The text states "Groundwater samples have been collected from eleven monitoring wells at Site M3 and analyzed for VOCs (as well as explosives, anions, metals, and semi-volatile compounds)." However, Tables C-2 and C-3 only include the results for up to two wells. Revise the report to resolve this discrepancy.*

Response: The language regarding the collection of samples from eleven monitoring wells at Site M3 was taken from the ROD. The text has been revised to reflect that VOC samples have been collected from two wells (MW233 and MW352) at Site M3 with a benzene exceedance occurring at MW233 during August 1991. Subsequent resampling during July and December 1998 and June and October 1999 yielded no other detections for benzene.

35. *Page 4-1, Section 4.1 - Revise this section per our March 1, 2004 telephone conference to explain the 1998 ROD had an interim component for the sites intended for future transfer to the USDA and the status of the interim sites Proposed Plan and ROD.*

    Response: Based on the March 4, 2004 telephone conference, the following has been added to Section 3.1.5 and Section 4.0; Appropriate final remedial actions for future USDA soils have been developed, evaluated, selected, and presented in the *Proposed Plan for the Soil Operable Unit, Interim ROD Sites* (U.S. Army, February 2004). The selected remedies for interim sites will be formally presented and approved by the appropriate regulatory agencies in accordance with the NCP, once the Final ROD for interim sites has been submitted. The date for the Final ROD for interim sites is expected to be during fiscal year 2004.

36. *Page 4-5, bullets - The text lists remedial action objectives (RAOs) associated with the GOU. These RAOs are not the same as those selected for the 1998 ROD, and some are more restrictive (the 5th and 7th objectives may be not met by meeting the ROD RAOs). Since the ROD RAOs are already presented on page 4-1, USEPA suggests removing the RAOs found on this page from the report.*

    Response: The reference to specific RAOs for the GOU have been deleted from text in the report.

37. *Page 4-6, paragraph 3 - This section indicates seven wells were damaged or destroyed during redevelopment activities. The number of wells that were damaged or destroyed and the fact the four of the original wells could not be located for abandonment is a cause for concern. Any of these problems could create conduits for residual or future contamination. This problem should be listed as an issue in Section 8.0. In addition, possible solutions or preventative measures for monitoring wells located in sites undergoing transfer should be documented in the report and implemented to prevent recurrence.*

    Response: The fact that seven wells have been damaged or destroyed during redevelopment activities at Site M13 and that four could not be properly abandoned has been added to Section 8 and summary form of the report. In addition, a recommendation has been added to Section 9 that land transfer documentation include acknowledgement by new landowners that monitoring wells be protected.

Language could be included that specifies consequences for not meeting deed requirements.

38. *Page 6-5, Section 6.5 - There is no documentation of the inspection referenced in this section. In the report, list items pertinent to the five-year review that are to be noted during the site inspections performed as part of the annual groundwater monitoring report (e.g., well condition, deed restrictions violations) and indicate who conducted the inspection (Army representative, contractor, etc.).*

    Response: The text has been revised to include when the inspection was conducted, who conducted the inspection, activities conducted during the inspection, and observations noted during the inspection.

39. *Page 6-6, Section 6.6 - The interviews did not include an interview with any of the new owners, operators or managers of the industrial park areas. Given that significant land use changes have occurred over the last five years, these types of interviews should be performed to allow for collection of any new information regarding site operations, evidence of contamination or possible changes to assumptions regarding receptors. If such interviews cannot be performed for the current review, they should be recommended as an additional action to be completed after the five-year review.*

    Response: Given the turn around time required for response to EPA comments it was not viable to conduct interviews with new owners or managers of properties in the industrial park areas. This data gap has been identified as an issue in Section 8 and a recommendation to conduct interviews has been added to Section 9.

    It is our understanding that the Army has included language in the deed for transferred property which requires an Annual Certification Letter be generated by the grantees certifying that the integrity of deed restrictions has not been compromised. The certificate is sent to the Army, the USEPA, and the IEPA (FFA Parties).

40. *Page 7-11, paragraph 1 - Define in the text what is described as an "undetermined" stable trend. Earlier text states the Mann-Kendall test would indicate whether a plume was increasing, stable, or decreasing.*

    Response: The undetermined stable trend reference pertains to the 1999 version of the Mann-Kendall spreadsheet. As stated in the response to comment EPA-10, the Mann-Kendall analysis was redone using the latest version of the Mann-Kendall spreadsheet (2/2001). There is no longer a reference to undetermined stable trend. The latest version determined if it is a stable or non-stable trend depending on the coefficient of variation (CV) for the data analyzed. If the CV is ≤ 1, a stable trend is determined and if the CV>1 no trend determination is made. Appropriate changes have been made to specific site discussions relating to Mann-Kendall analysis results.

41. *Sections 7.2, 7.3, and 7.4 - As a part of answering Question A for the specific sites, a determination should be made whether access controls (e.g., fencing, security guards) and institutional controls that are needed at this stage of the remediation are in place and successfully prevent exposure. If controls are not in place, determine why not, and obtain the schedule for implementation. Provide conclusions of this determination in the report.*

    Response: Table 7-10 has been added to the report. Table 7-10 summarizes implemented institutional controls, future land use, current owner, GMZ boundary figure references, and frequency of current monitoring. A reference to the table has been included in the appropriate subsection of Section 7.

42. *Section 7.2, and applicable subsections of Section 7.3, Findings to Question A - Remove the last sentence in all determinations that states the remedy will be "more protective". Remedies are either protective or they are not. It may be more appropriate to state the remedies are expected to be protective when remedial actions are complete for source soils.*

    Response: The text has been changed to read "The groundwater remedy is expected to be protective of human health and the environment when soil RA activities are completed at the site" for sites still requiring Soil remedial actions. For sites with soil RA activities completed, the statement was change to read "The groundwater remedy is protective of human health and the environment.

43. *Section 7.2, 7.3, and 7.4, Findings to Question C, last sentence - Modify the sentence to state, "Controls adequately prevent exposure to groundwater within the GMZ."*

    Response: The last sentence to Question C for each site has been changed to read "Controls adequately prevent exposure to groundwater within the GMZ".

44. *Page 7-23, Section 7.3.2.1, paragraph 1 - Provide an explanation for the sporadic detections of various explosive contaminants if possible.*

    Response: Recent sporadic detections for explosive compounds at Site M5 can be attributed to SOU RA activities conducted at the site during 1999 and disturbance of soil during redevelopment construction activities. Additional explanation has been added to the text of the report.

45. *Page 7-23, Section 7.3.2.1, paragraph 2 - Please clarify why a concentration versus time plot was generated for TNT and not generated for 2,6-DNT. 2,6-DNT was detected at a concentration about 100x greater than its RG in 1988 and was still detected above the RG in 2001, while TNT was detected at a concentration of about 2x its RG in 1988 but was not detected after 1988.*

    Response: A concentration versus time plot for 2,6-DNT for monitoring well MW207/MW207R at Site M5 has been added to the report as Figure 6-12. In addition, the exponential curve's slope and y-intercept were used to estimate a clean-up time for 2,6-DNT at Site M5. This information has been added to Table 6-1; Summary of Groundwater Trends: Estimated Clean-up Times. The estimated calculated clean-up time for 2,6-DNT for monitoring well MW207R is two years or in the year 2006.

46. *Page 7-23, Section 7.3.2.1, paragraph 2 - The text states TNT should have degraded to less than RGs by 1992. Describe in the text whether or not this is the case.*

    Response: The text has been revised to indicate that TNT has not been detected at monitoring well MW207R at Site M5 since 1988.

47. *Page 7-24, paragraph 2 - Clarify whether or not the findings in this paragraph (no well pairs to determine vertical gradients and not enough water table wells to calculate the horizontal gradient and linear velocity) represent a data gap. Provide any recommendations in Section 9.0.*

    Response: The lack of vertical and horizontal gradient data for Site M5 is not a concern. Because Site M5 is located just North of Grant Creek in a low topographic setting, vertical gradients in this area are likely upward. Horizontal gradients are not expected to be much different from those at surrounding sites. Unconsolidated deposits are rather thin at Site M5. Depth to bedrock ranges from 10 to 17 feet below ground surface at Site M5 and depth to water ranges from 10.7 to 11.5 feet below ground surface. The lack of water table wells is due to very little saturated unconsolidated deposits present at the site. The Silurian dolomite has demonstrated consistent hydraulic conductivities and linear flow velocities at surrounding sites. Additional explanation has been added to the text of the report.

48. *Page 7-28, end of Chemistry section - It is difficult to draw conclusions about the groundwater remediation at Site M6 because several statistical evaluations are*

presented with various, sometimes potentially contradictory, results. Provide additional information synthesizing the various sets of results.

Response: Additional text clarifying groundwater conditions at Site M6 have been added to Section 7.2.3.1.

49. *Page 7-29, last paragraph - The text states the model predicts the maximum predicted distance of the 2,4-DNT RG exceedance downgradient of well MW212R is beyond the GMZ boundary, but provides rationale why this is considered an overestimation. Discuss whether there is a need to sample the area near the TNT ditch and the wetlands, which is the most likely area to be impacted from groundwater contamination downgradient of MW212R. Provide any recommendations in Section 9.*

    Response: TNT ditch has been sampled semi-annually for surface water since the inception of the LTM Program. No RG exceedances have occurred for explosive compounds. In fact, only biodegradation byproducts 2a,4,6-DNT and 4a,2,6-DNT of TNT have ever been detected. In addition, monitoring wells MW123R and MW162R downgradient of MW212R have not had detections of explosives. Please note that remedial activities are being conducted on the TNT ditch in 2004 and may have an effect on sampling results.

50. *Page 7-34 - Discuss the results for sulfate at Site M8 wells MW360 and MW361 in the applicable sections and provide and determine if the exceedance effects the answers to Questions A, B, and C. Provide any recommendations for additional sampling in Section 9.*

    Response: The sulfate detections referenced at monitoring wells MW360 and MW361 at Site M8 occurred during 1992 and 1994. Monitoring wells MW360 and MW361 have been destroyed. The wells were located in Acid Area 3 near the former oleum plant in the northeast portion of Site M8. Raw sulfur was readily apparent throughout this area. Surficial sulfur was likely the source of sulfate detections at Site M8. Surficial sulfur was removed prior to signing the FOST for Site M8. Sulfur is not a regulated waste, and was not identified in the ROD as a COC. Sulfate RG exceedances at Site M8 have been identified as an issue in Section 8 and a recommendation to sample replacement well MW361R for sulfate has been made in Section 9 of the report. Resampling of MW361R will determine if elevated levels of sulfate still exist in that area.

    Please refer to response number 13 for information regarding background levels of sulfate present in groundwater in the vicinity of JOAAP. Because such high concentrations of sulfate exist in background wells (up to 15, 000 mg/L) the answers to questions A, B, and C are not affected.

51. *Page 7-37, paragraph 2 - Discuss whether the lack of bedrock wells at Site M13 represents a data gap, and provide any recommendations in Section 9.*

Response: Currently there are four bedrock wells at Site M13. Replacement well activities during January 2004 resulted in the installation of two bedrock wells (MW362 and MW364) and two previously installed bedrock wells (MW321 and MW322) still exist at Site M13. In addition, combined well MW350 is also partially screened in bedrock. The bedrock wells have sufficient spatial distribution so as to produce a representative potentiometric surface map for the site. In addition, numerous bedrock control points exist at Site M6 near the eastern boundary with Site M13 (MW213R, MW215R, MW308, MW314, MW315, and MW310R). Additional explanation has been added to the text of the report.

52. *Page 7-39, Hydrogeology - Discuss whether the lack of water table wells at Site M3 represents a data gap, and provide any recommendations in Section 9.*

Response: Depth to bedrock ranges from 2 to 10 feet below ground surface (BGS) at Site M3 and depth to water ranges from approximately 9 to 12 feet BGS. As illustrated in Figures 7-24 and 7-25, unconsolidated deposits are rather thin at Site M3. The lack of water table wells is due to the very little saturated unconsolidated deposits present at the site. Installation of wells strictly as water table wells at Site M3 would not be practicable. Therefore, the lack of water table wells at Site M3 does not represent a data gap. Additional explanation has been added to the text of the report.

53. *Page 7-40, Section 7.4.2 - This section should discuss the exceedance of sulfate in monitoring well MW331 at Site M10 and discuss whether a data gap exists. Provide any recommendations regarding this data gap in Section 9.*

Response: No data gap for sulfate exists for Site M10. According to Table B-1 (Sample Cross Reference and Analytical Schedule) of the Fall 1999 GOU Annual Report, sulfate samples were collected at Site M1 on November 3, 1999. No record of sulfate samples being collected at Site M10 during November 1999 exists. Table B-1 does indicate that a sample was collected from well MW331 at Site M1, but there is no monitoring well MW331 at Site M1. Further research into the misnomer indicated that no sample was listed for well MW231 at Site M1 in Table B-1. While checking the data base output, it was noticed that a detection for sulfate of 29,200 mg/L was also reported for monitoring well MW231 at Site M1 on November 3, 1999. It is apparent that while hand entering analytical results in to the data base that the result for sulfate was entered twice, once for monitoring well MW231 at Site M1 and for monitoring well MW331 at Site M10. Table C-3 has been updated to reflect no sulfate sample was collected at monitoring well MW331 at Site M10. This conclusion is validated because sulfate has never been a contaminant of concern at

Site M10. In addition, monitoring well MW331 was sampled during July 1998 as part of the baseline sampling conducted for GOU RD/RA Workplan preparation. Sulfate was not detected at MW331 during July 1998 and the method reporting limit was 1.0 mg/L. A recommendation to sample MW331 for sulfate could be made but the well has been abandoned.

Evidence exists that errors do occur in the data base used to generate tables for the GOU First Five-Year Review Report. Data base errors likely exist because data was hand entered from historic data tables, not electronic data deliverables (EDDs) from the analyzing laboratory. Resources and time were not available at the time of report preparation to alleviate errors in the data base. When errors have been found, the data base has been updated. It should be noted that the data base compiled for the GOU is not inclusive.

54. *Page 7-40, Findings of Question A - Modify the last sentence to state the remedy is protective.*

Response: The last sentence in findings of Question A have been changed to reflect that the remedy is protective of human health and the environment.

55. *Section 8.0 - Provide a recommendation for the issue identified for Site M7.*

Response: A recommendation of sampling monitoring well MW124R at Site M7 for VOCs has been added to Section 9.

56. *Section 8.0 - Include the destruction of monitoring wells by redevelopment activities as an issue and identify any related issues (lack of proper closure). Provide recommendations to resolve the issues.*

Response: Destruction of monitoring wells by redevelopment at transferred properties has been added to Section 8 as an issue. The issue of not having wells properly abandoned and the potential for the wells to act as conduits for residual or future contamination has been emphasized. Recommendations have been made in Section 9 of the report. Also see response to comment EPA-37.

57. *Page 9-4, Section 9.1.4, paragraph 1 - The text states no bedrock wells are located near the plume at Site L14. Only two bedrock wells are shown on Figure 7-36, so it is unclear how accurately the potentiometric surface map can be drawn. Discuss whether a data gap exists and provide any recommendations to resolve it.*

Response: Monitoring well MW140 was also used in constructing the potentiometric surface map for Site L14. While monitoring well MW140 is a combined well (screened across overburden and bedrock), the overburden in which the well is screened consists of cohesive (tight) soils and a discontinuous sand unit. Therefore, the groundwater elevation demonstrated at MW140 is likely representative of the bedrock unit. Contouring of three control points should produce a representative groundwater flow direction. Cross-sections for Site L14 indicate that a continuous sand unit exists across the site. A continuous clay unit underlies the sand and bedrock exists below the clay. Dissolved contaminants are likely following the higher permeable sand unit, while the clay restricts vertical migration. According to Figure 7-8, the clay unit does pinch out in the vicinity of monitoring wells MW603/MW604. Upward vertical gradients have been demonstrated at well nest MW603/MW604 throughout LTM activities at the site (Table 7-3). The upward vertical gradients would likely limit downward vertical movement. In fact, no detections of explosive compounds have occurred at monitoring wells MW603/MW604 since their inception during 1999.

58. *Page 9-7, Section 9.2.5 - Appendix C shows concentrations of sulfate exceeded the RG in monitoring wells MW360 and MW361 at Site M8. These wells (or replacement wells) should be added to the long-term groundwater monitoring program.*

    Response: Monitoring wells MW360 and MW361 have been destroyed. Monitoring well MW361 was replaced in 1998. The elevated level of sulfate at MW360 and MW361 have been added to Section 8 as an issue and a recommendation to sample monitoring well MW361R for sulfate has been added to Section 9 of the report.

59. *Page 10-1 - Remove the last sentences regarding the proposed LTM programs from the protectiveness statements.*

    Response: The last sentence regarding proposed changes to the LTM Programs have been removed from Section 10 and the First Five-Year Review summary form.

60. *Table 6-2 - The 1/yr decay rate (1.46E-01) shown for monitoring well MW412 at Site L3 is incorrect. Based on the 1/day decay rate of 1.0E-04, the 1/yr rate appears to require correction to 3.66E-02. Revise the table and appendix sheet accordingly.*

    Response: The reported value of 1.0E-04 1/day for the decay rate was incorrect. The value has been changed to 4.0E-04 1/day. The reported decay rate of 1.46E-01 1/yr was correct. Site L3 monitoring well MW412 first order decay rate constant calculation sheet has been updated in Appendix E. Table 6-2 required no changes.

61. *Figures, Site Features Maps - The information shown on Figures 3-3 through 3-9 is also shown on the corresponding water table and potentiometric maps; therefore, Figures 3-3 through 3-9 can be removed.*

Response: Figures 3-3 through 3-9 have been removed from the report. The title of the water table map for each site has been changed to reflect the map as Site Features/Water Table Map. Figures 3-10 and 3-11 have been renamed Figure 3-3 and 3-4.

62. *Appendix G, Site L2, MW404 - The vertical dispersivity value is shown as 3.3 feet (which is actually larger than the transverse dispersivity value of 3.2 feet). If the plume length is entered into the spreadsheet, the vertical dispersivity value should result as 0 (note, it may be necessary to click the restore formulas button).*

    Response: See response to comment EPA-63.

63. *Appendix G, Site M6, MW212R - The horizontal, transverse and vertical dispersion input values on the MW212R BIOSCREEN input sheet are 55.4, 5.5, and 15 feet, respectively. The data input summary indicates that the longitudinal and transverse dispersion values were entered automatically by BIOSCREEN once the estimated plume length (10,000 feet) was assigned, and that the vertical dispersivity is an estimated value. However, the vertical value shown on the input screen is incorrect. The vertical dispersivity value should have been 0, based on longitudinal and transverse dispersivities of 55.4 and 5.5 feet. It is not clear how the 15 foot vertical dispersivity value was derived, as it does not conform with any of the dispersion relationships programmed into BIOSCREEN. If a vertical dispersivity value of 0 is used in the model, the 900 foot first order concentration would be 452 ug/l instead of 4.4 ug/l.*

    Response: For the BIOSCREEN model runs in the five-year review report, the same input parameters were used as in the GOU RD/RA Workplan except for changing the first-order decay rate based on trend analyses conducted as part of the five-year review. Because the BIOSCREEN model is calibrated to field observations, altering any one parameter may necessitate modifying another parameter to compensate. For example, reducing the vertical dispersivity might be balanced by allowing for retardation. Because a specific attempt was made during the original modeling to use the most conservative inputs available, some instances occur where predicted RG distances exceed the GMZ boundaries. However, groundwater monitoring data indicates that RGs are not exceeded outside the GMZs.

FINAL
Five-Year Review Report

First Five-Year Review Report

for

Joliet Army Ammunition Plant (JOAAP)
Groundwater Operable Unit

Will County, Illinois

April 2004

Prepared for:
United States Army Corps of Engineers
Louisville, Kentucky

Prepared by:

MWH Americas, Inc.
Wilmington, Illinois

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Prepared by:	Mark D. Pauli Hydrogeologist	4/27/04 Date
Reviewed by:	Leo B. Linnemanstons Groundwater Operable Unit Manager	4/27/04 Date
Approved by:	Kurt L. Adams Task Order Manager	4/27/04 Date

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ACRONYMS AND ABBREVIATIONS

1,1-DCE	1,1-Dichloroethene
1,2-DCA	1,2-Dichloroethane
1,3-DNB	1,3- Dinitrobenzene
2,4-DNT	2,4-Dintrotoluene
2,6-DNT	2,6-Dintrotoluene
2a,4,6-DNT	2-amino-4,6-dinitrotoluene
2-NT	2-Nitrotoluene
3-NT	3-Nitrotoluene
4a,2,6-DNT	4-amino-2,6-dinitrotoulene
4-NT	4 Nitrotoluene
ARARS	Applicable or Relevant and Applicable Requirements
AST	Aboveground Storage Tank
ATK	Alliant Techsystems, Inc.
ATV	All Terrain Vehicle
BETX	benzene, toluene, ethyl benzene and total xylenes
BNSF	Burlington Northern Santa Fe
BTAH	Biological Technical Assistance Group
BTF	Biotreatment Facility
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
cm/sec	centimeters per second
COC	contaminant of concern
CV	coefficient of variation
cy	cubic yard
DNT	Dinitrotoluene
ESD	Explanation of Significant Difference
FFA	Federal Facilities Agreement
foc	soil organic carbon content
FOST	Finding of Suitability to Transfer
FS	Feasibility Study
GMZ	Groundwater Management Zone
GOU	Groundwater Operable Unit
GRU	Groundwater Remedial Unit
HMX	High Melting-Point Explosive
HRS	Hazard Ranking System
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency

JOAAP	Joliet Army Ammunition Plant
Kd	soil/water partitioning coefficient
koc	organic carbon/water distribution coefficient
LAP	Load-Assemble-Package Area
LDR	Land Disposal Restriction
LTM	Long Term Monitoring
MEK	methyl ethyl ketone
MFG	Manufacturing Area
mg/kg	milligram per kilogram
mg/L	milligrams per liter
MSL	mean sea level
MW	Montgomery Watson
MWH	MWH Americas, Inc.
n	effective porosity
NB	Nitrobenzene
NCP	National Contingency Plan
NFA	No Further Action
NPL	National Priority List
O&M	Operation and Maintenance
OU	Operable Unit
Pb	Aquifer Bulk Density
PCB	Poly-chlorinated Biphenyls
PCE	Tetrachloroethene
PL	Public Law
PRG	Preliminary Remediation Goals
PVC	polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
R&D	Research and Development
RA	Remedial Action
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	Royal Demolition Explosive
RED-OX	Reduction-Oxidation Potential
Rf	retardation factor
RG	Remediation Goal
RI	Remedial Investigation

ROD	Record of Decision
SOU	Soil Operable Unit
SRU	Soil Remedial Unit
SVOCs	semi-volatile organic compounds
TAT	2,4,6-Triaminotoluene
TCE	Trichloroethene
TCLP	toxicity classification leaching Procedure
TERC	Total Environmental Restoration Contract
THF	Tetrahydrofuran
TNB	Trinitrobenzene
TNG	1,3,5-Trinitrobenzene
TNT	2,4,6-Trinitrotoluene
ug/L	micrograms per liter
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Protection and Preventive Medicine
USAEC	United States Army Environmental Center
USAEHA	United States Army Environmental Hygiene Agency
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
UXO	unexploded ordnance
VOCs	volatile organic compounds
WES	Waterways Experiment Station

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EXECUTIVE SUMMARY

The remedy for the Groundwater Operable Unit (GOU) at the Joliet Army Ammunition Plant (JOAAP) is monitored natural attenuation of contaminated groundwater. The trigger date for this Five-Year review was the initiation of construction activities at Site M4 on May 5, 1999.

The assessment of this Five-Year review found that the remedy is complying with the requirements of the Record of Decision (ROD). One Explanation of Significant Difference (ESD) was issued to extend the Groundwater Management Zone (GMZ) at Site M1 – Southern Ash Pile. The action was taken in order to prevent potential groundwater withdrawals from outside the currently established GMZ borders at Site M1. The difference in scope associated with the GMZ border change included the reassignment of early warning and compliance wells. Performance of the remedy has been positively affected by the change in the GMZ boundary.

During the first five-year review period for the GOU, final closure was approved for Site M10 – Toluene ASTs, reducing the total number of sites in the GOU from 12 to 11. As the remedy continues in the second five-year review period, additional sites will be proposed for closure as remedial goals (RGs) are achieved.

The remedy remains protective of human health and the environment and will be complete when groundwater cleanup goals are achieved through monitored natural attenuation. Soil Operable Unit (SOU) remedial action (RA) activities, which include soil source removal, will likely decrease the timeframe needed for the monitored natural attenuation remedy to achieve groundwater cleanup goals.

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Five-Year Review Summary Form

Site name: Joliet Army Ammunition Plant – Manufacturing (MFG) Area – Load-Assemble-Package (LAP) Area		
EPA ID : IL7213820460 (MFG Area) IL0210090049 (LAP Area)		
Region: V	**State: Illinois**	**City/County: Wilmington / Will**
NPL status: ■ Final ☐ Deleted ☐ Other (specify)		
Remediation status (choose all that apply): ■ Under Construction ■ Operating ■ Complete		
Multiple OUs?* ■ YES ☐ NO	**Construction completion date:** N/A	
Has site been put into reuse? ■ YES ☐ NO		
Lead agency: ☐ EPA ☐ State ☐ Tribe ■ Other Federal Agency US Army		
Author name: Mark D. Pauli		
Author title: Hydrogeologist	**Author affiliation: MWH, USACE Contractor**	
Review period:** 5 / 5 / 1999 **to** 5 / 4 / 2004		
Date(s) of site inspection: Groundwater OU sites were inspected during the Fall 2003 groundwater monitoring event conducted during October 2003.		
Type of review: ■ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion		
Review number: ■ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify) ____		
Triggering action: ■ Actual RA Onsite Construction at SRU6 (Site M1) ☐ Actual RA Start at OU#____ ☐ Construction Completion ☐ Previous Five-Year Review Report ☐ Other (specify)		
Triggering action date *(from WasteLAN)*: 5 / 5 / 1999		
Due date *(five years after triggering action date)*: 5 / 4 / 2004		

* ["OU" refers to operable unit.]

** **[Review period should correspond to the actual start and end dates of the Five-Year Review in Waste LAN.]**

Five-Year Review Summary Form, cont'd.

Issues:

All Sites – Numerous wells are experiencing drawdown while conducting low-flow sampling because the aquifer cannot produce water at a rate equivalent to the purge rate (100 mL/min). Because drawdown is occurring at these locations, varying amounts of water from the standing water column are being sampled. A small-scale study is recommended to determine if wells experiencing drawdown are providing representative groundwater samples. About 10 to 20% of the wells which exhibit drawdown should be sampled using low-flow sampling techniques and conventional sampling by bailing or pumping dry and then collect samples within 24 hours of sufficient recharge. The samples should be collected during the same sampling event for best comparative analysis. Relative percent differences (RPDs) should be calculated between the two analyses to determine if the sampling technique should be altered for wells exhibiting drawdown during low-flow sampling.

Site M1 – In plume and early warning monitoring wells downgradient of the ash pile are exhibiting increasing concentrations of sulfate. SRU6 soil removal is the proposed remedy at Site M1. Since ash is in contact with groundwater at this site, removal of the waste should reduce contaminant loading to the groundwater. RA activities are scheduled to occur during fiscal year 2008. To date, no confirmed RG exceedances for sulfate in groundwater or surface water have occurred since expanding the GMZ.

Site M5 – Surface water sample location SWTET no longer receives surface water from Site M5. Surface water now runs to a large sedimentation basin southwest of the site due to redevelopment of the area surrounding Site M5. Sampling at SWTET should be discontinued. Sampling of the sedimentation basin should be conducted for explosives.

Site M6 - The ROD indicates that cadmium was detected at a concentration greater than the RG (5 ug/L) at monitoring well MW123 at Site M6 during 1982. No additional sampling for cadmium at MW123R (replacement well) has occurred since 1982.

Site M7 – PCE was detected at a concentration of 3.6 ug/L at monitoring well MW124R during December 1998. PCE exceeded the RG at well MW124 during November 1985. Monitoring well MW124R has not been sampled for VOCs since December 1998.

Site M8 – Sulfate exceeded the RG at monitoring wells MW360 and MW361 during 1992 and 1994. Both monitoring wells have been destroyed. Monitoring well MW361 was replaced in 1998. Monitoring well MW361R will be sampled for sulfate if the well is still functional.

Site M13 – Seven monitoring wells were damaged or destroyed during redevelopment activities at Site M13. Four of the original wells could not be properly abandoned because they could not be located. Wells not properly abandoned could create conduits for residual or future contamination. Measures need to be implemented to ensure that sites undergoing land transfer do not have monitoring networks damaged by redevelopment activities.

Transferred Properties – Interviews were not conducted with new owners, operators, or managers of transferred property to determine if new site operations are compliant with institutional controls set by the ROD. Additional information could be obtained regarding possible changes to assumptions regarding receptors and if evidence of additional contamination have been identified. In addition, provisions should be made to protect monitoring wells from destruction on transferred properties.

Recommendations and Follow-up Actions:

Recommendations for issues identified in Section 8 of this report include performing a field study to determine if monitoring wells exhibiting drawdown during low-flow sampling provide representative groundwater samples. Monitoring wells screened in cohesive silt and clay soils can not produce water equal to the pumping rate (100 mL/min) recommended for low-flow sampling. It is unknown if the water quality of stagnant water located in monitoring well riser pipes is being affected by exposure to atmospheric conditions (i.e. riser open to the atmosphere). It is evident that some of this water is being sampled in wells exhibiting drawdown during low-flow sampling. In an effort to determine if these samples are representative of actual groundwater conditions, it is proposed that a defined number of wells be sampled using low-flow techniques and be purged dry using a bailer or pump and sampled when sufficient recharge required for sampling occurs. Monitoring wells that historically have had detections are preferred for the field study. A comparison of analytical results should be made to determine if sampling technique should be altered for wells exhibiting drawdown while low-flow sampling.

Additional follow-up actions include:

- Continuation of semi-annual monitoring at Site M1 due to an increasing trend for sulfate at some site monitoring wells.
- Transfer the surface water sample location SWTET from its present location to the new sedimentation basin located in the west central portion of Site M5 and continue to analyze for explosives.
- Sample monitoring well MW123R at Site M6 for dissolved cadmium.
- Sample monitoring well MW124R at Site M7 for VOCs.
- Sample monitoring well MW361R at Site M8 for sulfate.
- For Site M13 and other transferred properties, perform interviews with new owners, operators, or managers to ensure deed restrictions are being followed and institutional controls implemented at the sites are still effective.

Monitoring well MW124R should be sampled for VOCs over two consecutive sampling events. If no detections for VOCs occurs, the need for further sampling should be evaluated.

The same sampling scheme should be followed for sedimentation sampling at Site M5 for explosives. The sedimentation basin is also the new surface water compliance point for the site since development activities have altered the flow of surface water. This surface water location is to be sampled until groundwater and surface water RGs for explosives have been met and site M5 is closed.

Interviews should be performed with new owners, operators, or managers of transferred properties. Interviews should be performed to allow for collection of any new information regarding site operations, evidence of contamination or possible changes to assumptions regarding receptors.

Seven monitoring wells were recently damaged during redevelopment activities at Site M13. Four could not be properly abandoned and could potentially create conduits for residual or future contamination. Land transfer documentation includes an acknowledgement form signed by landowners that monitoring well networks must be protected. In addition, land use restrictions and covenants and monitoring well restrictions and covenants for the property are specifically addressed in the deed. Language could be included that specifies consequences for not meeting deed requirements.

The Army and USACE are responsible for groundwater and surface water sample collection. MWH is currently under contract with the USACE to collect groundwater and surface water samples at GRUs identified in the ROD. IEPA and EPA are the agencies with oversight authority. Proposed follow-up actions should be initiated during the Spring 2004 monitoring event.

Protectiveness Statement(s):

The remedy for GRU1 remains protective of human health and the environment. Threats at the sites are being addressed through monitored natural attenuation and implementation of institutional controls. SOU RA activities will likely reduce the predicted clean-up times required for contaminant levels in groundwater to drop below RGs. The remedy for GRU2 remains protective of human health and the environment. Threats at the sites are being addressed through monitored natural attenuation and implementation of institutional controls. SOU RA activities have recently been completed at sites M5 (1999) and M7 (2001). Site M6 RA activities will likely be completed during the 2004 construction season. SOU RA activities will likely reduce the predicted clean-up times required for contaminant levels in groundwater to drop below RGs. RAOs in the ROD have been fulfilled for Site M8 based on analytical results from the last three semiannual monitoring events.

Threats at Site M3 have been addressed through monitored natural attenuation and implementation of institutional controls. The remedy for Site M3 remains protective of human health and the environment. RAOs set in the ROD will be fulfilled when SOU RA activities are conducted at the site.

All of the RAOs set in the ROD for Site M10 have been met and is protective of human health and the environment. The Final Site M10 Closure Report was submitted in March 2003.

Other Comments:

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1.0 INTRODUCTION

The purpose of the five-year review is to determine whether the remedy at the site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and recommendations to address them. This review focuses on the protectiveness of remedial actions at the Manufacturing (MFG) and Load-Assemble-Package (LAP) Areas, National Priority List (NPL) sites. These areas comprise the former Joliet Army Ammunition Plant (JOAAP), located in Wilmington, Illinois (Figure 1-1).

MWH Americas, Inc. (MWH) prepared this Five-Year Review report for the U.S. Army on behalf of the United States Army Corps of Engineers (USACE), Louisville District. The U.S. Army is the lead agency conducting this review. MWH has been contracted to provide remediation services under Total Environmental Restoration Contract (TERC) DACW27-97-D-0015. This Five-Year Review report was prepared pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Chapter 121 and the National Contingency Plan (NCP). CERCLA Chapter 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at each site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

This requirement is further interpreted in the NCP; 40 CFR Chapter 300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited and restricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

MWH conducted the five-year review of the remedy implemented for the Groundwater Operable Unit (GOU) at the MFG and LAP Areas of the JOAAP in Wilmington, Illinois. This review was conducted for the time period of May 5, 1999 through May 4, 2004. This report documents the results of the review.

This is the first five-year review for the GOU. The triggering action for this statutory review is the initiation of the construction of the soil stockpile area at Site M4 on May 5,

1999. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site within the GOUs at JOAAP above levels that allow for unlimited use and unrestricted exposure.

A separate Five-Year Review report is being prepared on behalf of the USACE by MWH for the Soil Operable Unit (SOU) at JOAAP. The SOU five-year review will encompass the sites at JOAAP where soil remediation has been conducted since the initiation of the construction of the soil stockpile area at Site M4 on May 5, 1999. Soil remediation has been implemented at JOAAP to address Contaminants of Concern (COCs) present as a result of historical activities at JOAAP. Details pertaining to the status of the selected remedies and the review process for the SOU will be made available by USACE upon completion of the Five-Year Review report.

2.0 SITE CHRONOLOGY

The site chronology begins when JOAAP was constructed during World War II to manufacture, load, assemble, pack and ship bombs, projectiles, fuses and supplementary charges. The chronology ends at the time this report was prepared. The following table provides the complete list of site events.

Event	Date
The JOAAP was constructed to manufacture, load, assemble, pack and ship bombs, projectiles, fuses and supplementary charges.	During World War II
Production of explosives halted; sulfuric acid and ammonium nitrate plants leased out; other production facilities put in layaway status.	1945
Production of explosives reactivated.	Korean and Vietnam Wars
Gradual decrease in production of explosives during the Vietnam War, then stopped completely.	1977
U.S. Army Environmental Center (AEC) conducted Installation Assessment and reported potential environmental impacts at former industrial areas.	1978
Installation Restoration Survey conducted by Donohue and Associates and included soil, groundwater, surface water and sediment samples at MFG and LAP areas.	1981-1982
Phase II investigation conducted by Donohue and Associates for additional data on previously sampled sites at MFG and LAP to assess off-site impacts. No off site contamination identified.	1983
Uniroyal (JOAAP's operating contractor) conducted a remedial action to remove contaminated surface water and sediments from Red Water Lagoon at M7.	1983-1985
Pre-remediation sampling at the Red Water Lagoon by Donohue.	1983
Post-remediation sampling at the Red Water Lagoon by Donohue.	1985

Event	Date
U.S. Army Environmental Hygiene Agency performed groundwater sampling at selected existing monitoring wells. This was part of JOAAP's Resource Conservation Recovery Act (RCRA) groundwater monitoring program at Site M13 and Red Water Lagoon at site M7.	1983-1985
MFG Area at JOAAP proposed for listing on NPL.	1984
LAP Area at JOAAP proposed for listing on NPL.	1985
Groundwater and surface water samples collected from previously sampled sites in the MFG and LAP Areas.	1985 and 1986
Dames and Moore presented groundwater and surface water data in a Site Assessment Report which discussed feasibility and need for remediation.	1986
Final NPL Listing for MFG at JOAAP.	1987
Dames and Moore conducts Phase I and Phase II Remedial Investigations (RIs) at MFG Area. Eighteen study areas identified for investigation.	1988-1993
Final NPL Listing for LAP at JOAAP.	1989
Federal Facilities Agreement (FFA) between the Army, United States Environmental Protection Agency (USEPA), and Illinois Environmental Protection Agency (IEPA) under CERCLA Section 120 and RCRA Sections 6001, 3008(h), and 3004(v). The FFA was to ensure investigations and remediation would be conducted.	1989
USACE investigated underground storage tanks (UST's) at JOAAP. One hundred seven USTs were identified, inventoried, and evaluated.	1989
Most USTs identified by USACE were removed.	1989-1993
Dames and Moore conducts Phase I and Phase II Remedial Investigations (RI's) at MFG Area. Eighteen study areas identified for investigation.	1988-1993
Dames and Moore conduces Phase I and Phase II RI's at LAP Area. Thirty-five study areas were investigated.	1991-1994

Event	Date
United States Army Center for Health Promotion and Preventative Medicine (CHPPM) conducted ecological risk assessments to evaluate if site contamination is impacting ecological receptors.	1993 – 1996
Baseline Risk Assessments conducted by Dames and Moore to quantify the potential human health risks posed by contamination identified by the RI's at the MFG and LAP areas.	1994 and 1995
United States Army CHPPM issues Phase I Ecological Risk Assessment Report.	1994
Field Screening of soil for explosives. Results included in feasibility studies (FS).	1995
United States Army CHPPM issues Phase II Aquatic Ecological Risk Assessment Report.	1996
Preliminary Remediation Goals (PRGs) established based on the risk assessments by OHM.	1996
USACE excavated and disposed of wastes at study area L2.	1996
USACE removed polychlorinated biphenyl (PCB) switch boxes from MFG area.	1996
USACE conducted a removal action along Prairie Creek at Site L3.	1996
Public Law 104-106 of Fiscal Year 1996 Department of Defense Authorization Act legislated specific terms for conveyance of JOAAP to various entitles.	1996
USACE performed interim removal action at the southern ash pile at area M1.	1997
USACE excavated and disposed of organics and PCB contaminated soil at area L6.	1997
Separate FSs prepared for the Groundwater and Soil Operable Units (OUs) for both the LAP (Dames and Moore) and MFG (OHM) areas.	1997
Proposed Plan for SOU and Proposed Plan for GOU prepared by U.S. Army to provide rationale for proposed remedies.	1997
Proposed Plan for SOU and Proposed Plan for GOU presented at a public meeting.	January 1998

Event	Date
Predesign Investigation activities including soil and groundwater sampling at MFG and LAP areas by MWH.	1998
Record of Decision (ROD) for SOU and GOU at MFG and LAP Areas is submitted by U.S. Army	October 1998
Final Remedial Design/Remedial Action (RD/RA) Workplan for SOU and GOU submitted by MW to USEPA and IEPA.	April 1999
Interim O&M activities conducted at Site M1 with cap replacement with an impermeable plastic liner.	April 28, 1999
Start of Construction of Site M4 Soil Stockpile Area (SOU and GOU Remedial Action Trigger (Start) Date)	May 5, 1999
RA activities by MW begin at MFG area Site M5.	July 7, 1999
RA activities by MW begins at MFG area Site M6	July 16, 1999
Site M6 – Soil excavation has occurred intermittently at the Site; however, bioremediation, confirmatory sampling, and disposal performed almost continuously.	1999 through 2004
Groundwater samples collected from identified site wells in the MFG and LAP Areas according to the RD/RA Workplan.	June through November 1999
RA Activities at Site M5 to remove SRU1 and SRU3 contaminated soils.	July through November 1999
Semi-annual Groundwater Monitoring Report – Spring 1999 – submitted to USEPA and IEPA.	September 1999
Leachate collection and disposal activities begin at Site M9 as part of leachate control system O&M activities.	November 1999
Thirty-six monitoring wells abandoned in the MFG and LAP Areas. Abandonment reports were submitted in the Semi-annual Groundwater Monitoring Report – Spring 2000.	December 1999, field activities. September 2000, reporting.
Ongoing soil bioremediation for explosives at Site M4.	1999 through 2004
Annual Groundwater Monitoring Report – Fall 1999 - submitted to USEPA and IEPA.	January 2000

Event	Date
Groundwater samples collected from identified site wells in the MFG and LAP Areas according to the RD/RA Workplan.	May and October 2000
Semi-annual Groundwater Monitoring Report – Spring 2000 - submitted to USEPA and IEPA.	September 2000
Submittal of Final Closure Report – Site M5	December 2000
Groundwater samples collected from identified site wells in the MFG and LAP Areas according to the RD/RA Workplan.	May 2001, semi-annual event. October 2001, annual event.
Soil excavation for bioremediation treatment for explosives from Site M7.	July through October 2001
An enhanced temporary landfill cap installed at Site M9 Landfill to promote run-off.	2001
Submittal of PCB Sites Final Closure Report. Sites L1, L7, L8, L9, L10, and L17.	December 2001
Annual Groundwater Monitoring Report – Fall 2000 - submitted to USEPA and IEPA.	March 2001
Twenty-six monitoring wells abandoned from the MFG Area. Documentation is provided in Semi-annual Groundwater Monitoring Report - Spring 2001.	March to May 2001, field activities. September 2001, reporting.
Semi-annual Groundwater Monitoring Report – Spring 2001 - submitted to USEPA and IEPA.	September 2001
Eighteen monitoring wells installed to replace previously abandoned wells in the MFG and LAP Areas. Documentation is provided in the Annual Groundwater Monitoring Report - Fall 2001.	September and October 2001, field activities. April 2002, reporting.
Groundwater samples collected by MW from site wells in the MFG and LAP Areas according to the RD/RA Workplan.	May 2001, semi-annual event. October 2001, annual event.
Soil excavation by MWH at Site M6 for bioremediation for explosives.	July through November 2002
Annual Groundwater Monitoring Report – Fall 2001 - submitted to USEPA and IEPA.	April 2002
Groundwater samples collected by MW from site wells in the MFG and LAP Areas according to the RD/RA Workplan.	May 2002, semi-annual event. October 2002, annual event.

Event	Date
Ordnance and explosives removed from LAP Area Sites L11 and L16.	August 2002
Three sumps and one concrete outflow removed from LAP Site L16.	August 2002
Arsenic contaminated soil excavated from LAP Area L11, confirmation samples collected, soil disposed of at Laraway Landfill in Elwood, Illinois.	October and November 2002
Explosives contaminated soil excavated by MWH at LAP Site L16 for bioremediation review of groundwater results.	October 2002
Semi-annual Groundwater Monitoring Report – Spring 2002 - submitted to USEPA and IEPA.	November 2002
Explanation of Significant Difference (ESD) prepared by USACE for Site M1 modifying the groundwater management zone (GMZ) boundaries was submitted to the USEPA and IEPA.	February 2003
Site M10 Final Closure Report submitted by MWH.	March 2003
Annual Groundwater Monitoring Report – Fall 2002 - submitted to USEPA and IEPA.	March 2003
Groundwater samples collected by MWH from site wells in the MFG and LAP Areas according to the RD/RA Workplan.	May 2003, semi-annual event. October 2003, annual event
Agency approvals secured on the Final ESD for Site M1.	May and June 2003
Semi-annual Groundwater Monitoring Report – Spring 2003 - submitted to USEPA and IEPA.	October 2003
Submittal of Final Closure Report Site M7.	November 2003
Submittal of Final Closure Report Sites L11/L16.	December 2003
Well abandonment and replacement activities at Site M13. Documentation included as Appendix D of Fall 2003 GW Report.	January 2004, field activities Reporting – on going.
Annual Groundwater Monitoring Report – Fall 2003 submitted to USEPA and IEPA.	March 2004

3

3.0 BACKGROUND

3.1 GENERAL SITE BACKGROUND

This section describes the fundamental aspects of the site and provides a clear, succinct description of site characteristics. The purpose of this section is to identify the threat posed to the public and environment at the time of the Record of Decision (ROD), so that the performance of the remedy can be easily compared with the site conditions the remedy was intended to address.

3.1.1 Physical Characteristics

JOAAP is a former Army munitions production facility located on approximately 36 square miles (23,542 acres) of land in Will County, Illinois. The site is located approximately 3 miles north of Wilmington, Illinois, a community of approximately 5,134 residents. The JOAAP property is divided into two main functional areas by a public highway: the MFG Area, west of Route 53, and the LAP Area, east of Route 53.

The MFG Area, covering approximately 14 square miles (9,159 acres), is where the chemical constituents of munitions, propellants, and explosives were produced. The production facilities were generally located in the northern half of the MFG Area. In the southern half of the MFG Area, there was an extensive explosives storage facility.

The LAP Area, covering approximately 22 square miles (14,383 acres), is where munitions were loaded, assembled, and packaged for shipping. The LAP Area contained munitions filling and assembly lines, storage areas, and a demilitarization area.

The structural geology of northeastern Illinois, like most of the mid-continental region, is not complex. JOAAP is situated on the Kankakee Arch, a broad structural high that separates the Michigan Basin to the northeast from the Illinois Basin to the south. The rock strata in the vicinity of JOAAP dip gently to the east at a slope of about 10 feet per mile (less than 1 degree), indicating that JOAAP is on the east flank of the arch.

The Sandwich Fault Zone passes through the eastern portion of JOAAP. This is a major regional fault zone that has been mapped for 85 miles in a northwesterly direction from Will County to Ogle County, Illinois.

Two glacial deposits have been identified at JOAAP: the Henry and the Wedron formations. The Henry Formation underlies most of the outwash plain in the central and western parts of the MFG Area. It includes sandy and gravelly silts and distinct beds of sand and gravel, and is 5 to 25 feet thick. The Wedron Formation is extensive in the upland area east of the main part of the MFG Area and continues across the LAP Area. This formation is a till composed of clayey silt with minor sand. The combined thickness of both Wedron and Henry formations is generally less than 25 feet in the western part of the MFG Area. In the eastern part of the MFG Area, the thickness increases to 60 to 70 feet.

Groundwater flow is generally westward from the upland area to the low-level plain. The potentiometric surface across the facility ranges from an elevation of 610 to 530 feet MSL. Groundwater flow occurs in several aquifers identified beneath the site. The shallow overburden aquifer is composed of glacial drift and is underlain by the Silurian Dolomite aquifer. Deeper bedrock aquifers are isolated from these shallow aquifers by the low-permeability shale beds comprising the Maquoketa Group, which is a regional aquitard.

Surface water drains either to the Des Plaines or Kankakee Rivers, whose confluence is adjacent to the western boundary of JOAAP. The LAP Area drains via several creeks and ditches to the Kankakee River, whereas the MFG Area drains via several creeks, ditches, and storm water conveyances to either the Des Plaines or Kankakee Rivers. The Grant Creek basin and the Prairie Creek basin cover approximately 70 percent of the installation (Diodato et. al., 1991). Studies of historical floods in the area by the U.S. Geological Survey (USGS) and 100-year flood maps indicate that portions of the LAP Area are subject to flooding. Depending on the hydraulic conditions, the streams and creeks may either be net influent (gaining) or effluent (losing) with respect to the shallow aquifers.

3.1.2 Land and Resource Use

JOAAP was constructed during World War II. The production output varied with the demand for munitions. Although the plant was used extensively during World War II, all production of explosives halted in 1945. At that time, the sulfuric acid and ammonium nitrate plants were leased out, and the remaining production facilities were put in layaway status. The installation was reactivated during the Korean War, and again during the Vietnam War. Production gradually decreased until it was stopped completely in 1977. Since then, various defense contractors under facility-use contracts have utilized some areas of the installation. In April 1993, JOAAP property was declared as excess by the Army and is now being maintained by a small staff under liquidation status. The facility is no longer capable of explosives production and is undergoing transfer of use to other agencies and organizations in accordance with Public Law (PL) 104-106.

This law, entitled the Illinois Land Conservation Act of 1995, PL 104-106, Div. B, Title 2901-2932, February 10, 1996, states that the Army will transfer JOAAP land to various federal, local, and state jurisdictions. Transfer of land is occurring incrementally as it is remediated and is deemed appropriate. As of January 2004, the distribution of JOAAP land through these incremental transfers is approximately 19,100 acres to the U.S. Department of Agriculture (USDA) for establishing the Midewin National Tallgrass Prairie; 982 acres to the Department of Veterans Affairs to establish a Veterans Cemetery; 455 acres to Will County, Illinois to establish the Will County Landfill; and 2026 acres to the State of Illinois to establish two industrial parks.

3.1.3 History of Contamination

Due to the presence of contamination in both groundwater and soil at JOAAP, separate operable units were established for each media to address remediation objectives at the site. The GOU consists of the sites where impacted groundwater was identified (Figure 3-1). Site boundaries are defined by groundwater management zones (GMZs) that were identified in the *Record of Decision (ROD), Soil and Groundwater Operable Units, Manufacturing and Load-Assemble-Package Areas* (U.S. Army, October 1998). The GMZs define boundaries in three-dimensional space that encompass impacted groundwater at each site. The horizontal boundaries of each GMZ completely contain the contaminant plumes identified at each site, including an appropriate buffer allowing for potential plume migration. These GMZs include the glacial drift and shallow bedrock aquifers and are bounded vertically by the upper surface of the Maquoketa Formation.

The sites within the GOU are grouped according to contaminant type and their geographic location. These groups are referred to as Groundwater Remediation Units (GRUs). Three GRUs were identified in the ROD: two in the MFG Area and one in the LAP Area. Because the Feasibility Study (FS) Reports for these areas were completed independently, their original designations resulted in two GRU1 designations and were subsequently re-identified in the ROD. The following table identifies each GRU (including the designations from the FS Reports), the types of contamination discovered, the study sites beneath which the groundwater plumes are located, and the primary contaminants present in the plumes.

Groundwater Remedial Units (GRUs)

GRUs	Name	GRUs (In FSs)	Primary Contaminants of Concern	Sites
GRU1	Explosives in Groundwater	GRU1L	Explosives: 2,4-DNT, 2,6-DNT, TNB, TNT, RDX, and NT	L1, L2, L3, L14
GRU2	Explosives and Other Contaminants in Groundwater	GRU1M	Sulfate Explosives: 2,4-DNT, 2,6-DNT, TNB, TNT, HMX, RDX, NB, DNB VOCs: Tetrachloroethene (PCE) Metals: Iron, Antimony, Cadmium	M1, M5, M6, M7, M8, M13
GRU3	Volatile Organic Compounds in Groundwater	GRU2M	Toluene, Benzene	M3, M10 (Western and Central)

Note: The letters M and L were added to each GRU in the third column to differentiate between MFG and the LAP sites.

These GRU designations are important since the selected remedies are directly tied to the specific remedial units. However, in the case of groundwater, the selected remedy is the same for the GRUs. Monitored natural attenuation is identified as the remedy for the three GRUs. The groundwater remedy is also related to the source removal remedy that is addressed under the SOU. GOU monitoring well networks and GMZ boundaries are depicted on Figure 3-2.

Because surface water was found to pose no risk to health and the environment, it is not addressed further as a contaminated media. However, groundwater discharging to surface water may occur and cause localized detections of contaminants of concern (COCs) at certain sites within the GOU.

A summary of initial responses at JOAAP, along with the general basis for taking actions at JOAAP, is presented in the remainder of this section. Because residual soil contamination may be a source of groundwater impacts, SOU information has been included to provide a comprehensive explanation for GOU actions.

Site specific information describing physical characteristics, source(s) and history of contamination, initial response, and basis for taking action is presented in Section 3.2.

3.1.4 Summary of Initial Responses

In 1978, the U.S. Army Environmental Center (USAEC, formerly the U.S. Army Toxic and Hazardous Materials Agency or USATHAMA) conducted an Installation Assessment of JOAAP (USATHAMA, 1978), which consisted of a records search and interviews with employees. This document reported that environmental impacts might be present at former industrial areas and locations where waste disposal activities occurred.

In 1981 and 1982, an Installation Restoration Survey was conducted (Donohue and Associates, 1982). This study included sampling of soils, groundwater, surface water, and sediment, and identified the presence of contamination at nine study areas at the MFG Area and nine study areas at the LAP Area.

Subsequently, a Phase II study was conducted in 1983 (Donohue and Associates, 1983) to gather additional data on the previously sampled sites at the MFG and LAP Areas, and to evaluate the potential for off-site impacts. This investigation also included an assessment of several parcels of land near the edge of the MFG Area that were considered excess holdings. No off-site contamination was identified.

From 1983 through 1985, a remedial action was conducted by Uniroyal (JOAAP's operating contractor) at the Red Water Lagoon located at Site M7. The purpose of this remedial action was to remove contaminated surface water and sediment from the lagoon. Following the removal of contaminated surface water and sediment, a clay cap was installed over the former lagoon. Pre- and post-remediation sampling documented the conditions before and after the remediation (Donohue and Associates, 1983, 1985).

Between 1983 and 1985, the U.S. Army Environmental Hygiene Agency (AEHA; now U.S. Army Center for Health Promotion and Preventive Medicine, CHPPM) performed groundwater sampling at selected monitoring wells. The sampling and monitoring were performed as part of JOAAP's RCRA groundwater monitoring program around a closed sanitary landfill located at Site M13, and the aforementioned Red Water Lagoon at Site M7.

In November 1984, because of the presence of contamination, the MFG Area of JOAAP was proposed by the USEPA for listing on the NPL based on the Hazard Ranking System (HRS) score of 32.08. The LAP Area was proposed for listing in April 1985 based on the HRS score of 35.23. Final listing on the NPL took place on July 21, 1987 for the MFG Area, and March 31, 1989 for the LAP Area.

During 1985 and 1986, additional groundwater and surface water samples were collected from previously sampled locations at the MFG and LAP Areas. The results were presented in an assessment report in which the need and feasibility of remediation in the study areas were discussed (Dames & Moore, 1986).

In 1989, the Army, the USEPA, and the IEPA entered into a Federal Facilities Agreement (FFA) under CERCLA Section 120 and RCRA Sections 6001, 3008(h), 3004(u), and 3004(v) (USEPA, 1989). The purpose of the FFA was to document that environmental impacts at the site would be investigated and that remedial actions would be taken to protect public health, welfare, and the environment. Also during 1989, the USACE conducted an investigation of underground storage tanks (USTs) throughout JOAAP (USACE, 1989). A total of 107 USTs were identified, inventoried, and evaluated for possible leakage in accordance with USEPA regulations. Most of the USTs were emptied and removed as of 1993.

From 1988 through 1993, Phase I and Phase II Remedial Investigations (RIs) were conducted at the MFG Area (Dames & Moore, 1991, 1993). The RIs were performed to identify the type, concentration, and extent of contamination throughout the MFG Area. A total of 18 study areas were identified for investigation, including the nine areas in the MFG Area first identified and investigated during the Installation Restoration Surveys in 1981 and 1982. These reports were amended by the Oleum Plant RI Report (Dames & Moore, 1996) that was added as a potentially contaminated area following the completion of the RI reports.

From 1991 through 1994, Phase I and Phase II RIs were conducted at the LAP Area for the same purposes as the MFG Area investigations (Dames & Moore, 1993; 1994). A total of 35 study areas were investigated, including the nine areas in the LAP Area first identified and investigated during the Installation Restoration Surveys in 1981 and 1982.

These RI reports for the MFG and LAP Areas were supplemented by baseline risk assessments conducted to quantify the potential human health risks posed by contamination identified at the study areas identified in the MFG and LAP Areas (Dames & Moore, 1994; 1995). The assessments included an environmental fate and transport assessment, a toxicity assessment, an exposure assessment, and a risk characterization.

From 1993 through 1996, the U.S. Army CHPPM conducted an ecological risk assessment to evaluate the potential for site contamination to be impacting ecological receptors. Findings indicated limited impacts to terrestrial mammals, aquatic receptors, and avian species (birds). The results of these studies were presented in a Phase I Ecological Risk Assessment Report (CHPPM, 1994) and a Phase II Aquatic Ecological Risk Assessment Report (CHPPM, 1996). Potential risks posed to humans from consuming deer tissue from JOAAP were also investigated and determined to be negligible (CHPPM, 1994).

Following the risk assessments, Preliminary Remediation Goals (PRGs) were established to identify the specific cleanup levels to remediate the sites (OHM, 1996). These cleanup levels were developed to be protective of human health and the environment.

In 1996 and 1997, the USACE conducted three removal actions to prevent the migration of contaminants from the identified source areas. First, wastes present in the oil pits located at Site L2 were excavated and disposed to prevent impacts to groundwater. Second, PCB switch boxes and impacted soils were removed from the MFG Area. Soils around the switch boxes were sampled and removed if PCB concentrations were above PRGs or if staining was observed. Third, a RA was performed at Site L6 involving the excavation and disposal of organics- and PCB-contaminated soil to facilitate the transfer of the land in accordance with PL 104-106 from the Army to Will County for the purpose of establishing a landfill.

In 1996 and 1997, the USACE also conducted two interim actions to mitigate waste migration. First, an interim action was performed along Prairie Creek at Site L3 involving the stabilization of the stream bank to prevent the erosion of the bank containing buried debris and wastes. Second, interim maintenance activities were performed at the southern ash pile (Site M1) involving consolidation of wastes that had migrated from the pile and then covering the pile with a temporary geosynthetic liner to prevent leaching to groundwater.

The Fiscal Year 1996 Department of Defense Authorization Act contained PL 104-106, which legislated specific terms relating to the conveyance of JOAAP to various entities. This law is the governing document for the future land use at JOAAP. The majority of JOAAP is anticipated to be transferred to the USDA, with the U.S. Department of Veterans Affairs, Will County, and the State of Illinois also receiving portions of the property.

Since the volume of explosives-contaminated soil may have a direct bearing on the selected remediation method, field screening soil sampling programs were conducted in 1995 to provide data to more accurately estimate the volume of explosives-contaminated soils in the MFG and LAP Areas. These programs were supplemented by sampling to help characterize the types of wastes present. The results of the sampling programs were used in the FSs for the MFG and LAP Areas. The purpose of the FSs was to identify and evaluate alternative remedies for mitigating the risks posed by contamination at JOAAP. Separate FSs for the GOUs and SOUs were prepared in 1997 by Dames & Moore for the LAP Area and by OHM for the MFG Area. Based on the information gathered and presented in the FSs, the Army recommended, with USEPA and IEPA concurrence, the preferred remedies for the contaminated soil and groundwater at JOAAP. The rationale for the selection of the remedies was released to the general public in the Proposed Plan for the SOU and the Proposed Plan for the GOU (U.S. Army, 1997 a, b) and presented at a public meeting on January 8, 1998.

Alliant Techsystems, Inc. (Alliant)_ was under a facility-use contract to the U. S. Army until 1999. Alliant demobilized from the site during 2000. Plexus Scientific Corporation (Plexus) is currently under contract with the U. S. Army to perform decontamination and demolition activities for buildings contaminated by historic activities at JOAAP. Plexus's first work was conducted at the continuous lines at Site M6 during January 2000. Contamination resulting from decontamination and demolition activities will be remediated as required by the contract, applicable laws, and regulations.

Liquidation/demolition activities have been underway in the MFG Area since 1998. This action has removed many property items and buildings, and has potentially affected the extent of contamination previously determined in the RI and FS reports. The remedies selected for the SOU and GOUs accounted for potential changes in conditions that could be reasonably anticipated as a result of the ongoing liquidation/demolition and redevelopment activities.

3.1.5 General Basis for Taking Action

The human health risk assessments identified a total of 79 COCs in soil and sediment, 40 COCs in groundwater, and 45 COCs in surface water at JOAAP. Explosives (primarily 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), royal demolition explosive (RDX), high melting-point explosive (HMX), and tetryl were the most prevalent COCs in each of these media. Other contaminants including metals, pesticides, PCBs, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs) were also identified.

According to the ROD surface water was found to pose no hazard to health and the environment and therefore is not addressed further as a contaminated media. However, groundwater discharging to surface water may occur and cause localized detections of COCs at certain sites within the GOU.

The prevalent COCs are listed below.

Soil and Sediment

Explosives	**Metals**	**Polychlorinated Biphenyls**
2,4-Dinitrotoluene	Arsenic	Aroclor 1254
2,6- Dinitrotoluene	Beryllium	Aroclor 1260
Trinitrobenzene	Cadmium	
Trinitrotoluene	Lead	
Royal Demolition Explosive (RDX)		
High Melting Point Explosive (HMX)		
Nitrotoluene		

Groundwater

Explosives	Metals	VOCs
2,4-Dinitrotoluene	Iron	Tetrachloroethene
2,6- Dinitrotoluene	Antimony	Toluene
Trinitrobenzene	Cadmium	Benzene
Trinitrotoluene		
Royal Demolition Explosive (RDX)		
Nitrotoluene		

Based on information presented in the human health risk assessments, the principal threat results from potential exposure to explosives in soil. DNT is identified by USEPA as a probable human carcinogen, and both TNT and RDX are identified by USEPA as possible human carcinogens. Risks and hazards for groundwater are calculated based on the assumption that contaminated groundwater is used for potable water supply using a commercial/industrial exposure scenario. This scenario is unlikely to occur because the majority of the contaminated groundwater resides in the glacial drift aquifer that does not provide usable quantities of groundwater and is not used for water supply at JOAAP. Furthermore, deed restrictions placed on contaminated properties transferred by the Army prevent the use of groundwater until cleanup levels are achieved.

Sections 6.1 and 6.2 of the October 1998 ROD discuss in detail the exposure scenarios for human health and ecological risk assessment. These sections defined and determined the unacceptable risks for soil and groundwater.

Exposure levels for ecological resources that are protective of the environment and compatible with development of the tallgrass prairie are currently under development for the land to be transferred to the USDA. Exposure levels will be established by a site-specific biological technical assistance group (BTAG) that shall include, at a minimum, representatives of the Army, USEPA, IEPA, USDA, Illinois Department of Natural Resources, and Department of Interior/US Fish and Wildlife Service. The exposure levels established by the BTAG shall be compared to the human health risk-based remediation goals established for the lands intended for transfer to the USDA. Appropriate final remedial actions for future USDA soils will be developed, evaluated and selected and presented in the *Proposed Plan for the Soil Operable Unit, Interim ROD Sites* (U.S. Army, February 2004). The selected remedies for interim sites will be formerly presented and approved by the appropriate regulatory agencies in accordance with the NCP, once the Final ROD for interim sites has been submitted. The submittal date for the Final ROD for interim sites is expected to be during fiscal year 2004.

Although separate GOUs and SOUs exist, SOU cleanup is directly related to the GOU because of the potential for contaminated soils to be a continuing source of groundwater contamination. Source removal in the SOU is an important factor in the selection and success of the GOU remedy of monitored natural attenuation.

3.2 SITE SPECIFIC BACKGROUND INFORMATION

The following subsections provide a description of the individual sites of concern at identified GRUs at JOAAP. Site specific descriptions include the physical characteristics, land and resource use, history of contamination, initial responses, and basis for taking action at each site.

3.2.1 GRU1, Explosives – LAP Area

GRU1, Explosives in Groundwater, is entirely in the LAP Area and consists of separate plumes emanating from sources at Sites L1, L2, L3, and L14 (Figures 7-29, 7-32, 7-35, and 7-38, respectively). Explosives are the only contaminants identified in these plumes that could pose a risk to human health or the environment. The GRU1 plumes are present in the glacial drift aquifer for all sites. The plumes extend into the upper bedrock aquifer for Sites L1, L2 and L3 but not for Site L14. The following table lists the sites included in GRU1 and the estimated volume of impacted groundwater in the plumes at each site based on estimates provided in the ROD.

GRU1 Sites (Explosives in Groundwater –LAP Area)

Sites	Subareas	Volumes (Million Gallons)
L1	Groundwater related to the ridge-and-furrow area	69
L2	Groundwater downgradient of burning pad area	4
L3	Groundwater downgradient of burning cage	2
	Groundwater downgradient of bermed area	10
L14	Groundwater downgradient of sumps at Bldg. 4-5	2
Total		87

The following table lists exceedances of remedial goals (RGs) for groundwater in GRU1.

Exceedances of RGs for Groundwater in GRU1

MIDEWIN TALLGRASS PRAIRIE AREAS (USDA)					
Site		L1	L2	L3	L14
Explosives	RG (µg/l) USDA	Maximum Concentration Exceeding RGs (µg/l)			
1,3,5-TNB	5.1	1,300			
2,4,6-TNT	9.5	1,900			
2,4-DNT	0.42	2.01			
2,6-DNT	0.42	8.54			
RDX	2.6	56.50	640	77.90	840
Affected Aquifers		GD, SB	GD, SB	GD, SB	GD
Contaminated Volume (MG), Total	87	69	4	12	2

Key: *GD* *glacial drift, shallow aquifer*
SB *shallow bedrock aquifer*

3.2.1.1 Site L1 (Building Group 61). Site L1 was constructed in 1941 as part of the initial operations of the installation to support World War II efforts. This 80-acre site is centrally located in the northern portion of the LAP Area (Figure 7-30). Site L1 was the location of demilitarization and reclamation of various munitions. It was originally used for crystallizing ammonium nitrates, but then extensively modified to function as a shell renovation and 1,3,5-trinitrobenzene (TNB) recovery plant until 1945. In April 1946, the facility was reactivated to reclaim TNT. Washout operations involving the larger munitions were performed outside Building 61-35, which is located southeast of Building 61-4. The solids that settled in the sump were sent to Site L2 (Explosive Burning Grounds), while the overflow from the sump (pink water) was discharged to an adjacent 4.3-acre ridge-and-furrow system (or evaporating bed).

Historical aerial photos revealed that by 1952 two rectangular pits or lagoons had been constructed southeast of the ridge-and-furrow system on either side of the drainage ditch that flows south from the ridge-and-furrow system and empties into Prairie Creek.

Explosives contamination appears to be limited to the ridge-and-furrow system, the western lagoon south of the evaporation beds, the area south of the washout building and around the sump building.

2,4,6-TNT is considered to be a contaminant in the sump surface water. The presence of 2,4,6-TNT in the sediment from the ditch indicates that runoff from the ridge-and-furrow system may have periodically transported contaminants to Prairie Creek.

Two transformers removed in August 1990 from an area east of Building 61-4 were suspected to have leaked oil-containing PCBs onto site soil. The spill was subsequently cleaned up.

Remedial activities were conducted between August and October 1999 to remove PCB contaminated soil from Site L1. Remedial activities resulted in excavation of 155 cy (201.5 tons) of non-Toxic Substances Control Act (TSCA)-regulated PCB impacted soil from Site L1. PCB impacted soils above RGs from Site L1 have been excavated and disposed from Site L1. RGs, and RAOs set in the ROD for these soils have been met.

Field reconnaissance identified petroleum-stained soils near aboveground storage tank (AST) locations west of Building 61-1 and north of Building 61-2. In the vicinity of the AST location at Building 61-1, samples were collected at the surface and at depths of 2.5 and 5 feet (ft). Total Petroleum Hydrocarbons (TPH) were detected in all samples at concentrations above the RGs. The surface area contaminated by TPH is estimated to be 2,500 ft^2 and contamination is assumed to extend to a depth of 10 ft. This volume of soil is estimated to be 925 cy (1,203 tons). In the vicinity of the ASTs located at Building 61-2, soils below the ASTs within the surrounding earthen berm are heavily saturated with petroleum products and presumably are contaminated with TPH above the cleanup levels. The hydrocarbon-stained soils are limited to the area within the earthen berm surrounding the tanks, which is approximately 900 ft^2 based on field measurements. Therefore, the volume of contaminated soil north of Building 61-2 is estimated to be 350 cy (455 tons), assuming contamination extends to a depth of approximately 10 ft below grade.

The contaminants detected at elevated levels in groundwater at Site L1 are explosives (TNB, TNT, 2,6-DNT, and RDX). Groundwater contamination at Site L1 originated as a result of contaminant migration from the ridge-and-furrow area, with the plume extending southward toward MW172 and MW173. Given the relatively high concentrations of explosives in soil on-site, contaminant migration from soil to groundwater may also be occurring, although the majority of the groundwater contamination is attributed to the infiltration of discharged liquids.

No RCRA hazardous wastes were identified at Site L1.

Site L1 is not located near a heavily populated area. The future land use for Site L1 is intended for development into the USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soils and groundwater at the site were stated to pose an unacceptable hazard to future recreational users. Final groundwater RGs were established in the ROD for the site. Once final soil RGs are designated for the USDA lands, remedial action activities will be conducted to clean up contaminated soil. Remedial action activities are scheduled to occur during fiscal year 2005.

3.2.1.2 Site L2 (Explosives Burning Grounds). Site L2 is located in the west-central portion of the LAP Area, adjacent to Prairie Creek and Kemery Lake (Figure 7-33). The operational area covers approximately 5 acres and consists of six east-west pads, each approximately 650 feet long and 50 feet wide, on which explosives and associated wastes from Sites L7 to L10, L14, and L1, were burned. Three north-south burning pads were also present east of this area in 1952 aerial photographs. These pads were subsequently reconfigured into one pad, and the south oil pits were constructed on the southern portion of these pads. Several parallel, elevated burning pads were constructed of gravel and fitted with electric igniters operated from a remote location. According to JOAAP personnel, spent carbon from the carbon units used in the TNT/Composition B melt-load processes was also incinerated on the burning pads. Unexploded ordnance (UXO), including fuses and other items have been identified to be present on the burning pads.

Three popping furnaces, where small ammunition was detonated, were located at the southwest corner of the site. During operations, metal waste from the furnaces was removed and sent to the Salvage Yard (Site L5). Site L2 also contained three solvent and oil disposal pits (each less than 0.25 acre) located adjacent to the burning pads, which (according to JOAAP personnel) were occasionally used to burn waste oil. These pits were remediated in 1996 as part of a removal action conducted by the U.S. Army, and UXO was discovered to be buried in an area north of the burning pads. The UXO was disposed of properly as part of the removal action, although a complete UXO sweep was not performed, and it is possible that additional UXO remains at the site in the vicinity of the former solvent and oil disposal pits.

Drainage features include two ditches, which flow from the northern portion of the burning pads to Kemery Lake, and a gully at the southwestern corner of the site, which receives runoff from the popping furnace area and southern portions of the site.

An area approximately 200 ft^2 surrounding and including the popping furnaces is estimated to require remedial actions for arsenic, cadmium, and lead. Surface soil contaminated with arsenic, cadmium, and lead has been estimated to extend to a depth of 1 ft, representing a volume of 1,480 cy (1,924 tons). Additionally, arsenic contamination in subsurface soils around the popping furnaces is estimated to occur to a depth of 3 ft, representing a volume of 2,960 cy (3,848 tons). These soils are not known to have affected groundwater.

Analytical results for soil samples collected at Site L2 indicate that the majority of the burning pads area (approximately 206,500 ft^2) is contaminated with 2,6-DNT, RDX, arsenic and lead, all above the respective RGs. The total volume of soil at this site that exceeds RGs for explosives and lead is estimated to be 16,350 cy (21,255 tons).

Waste disposal activities at this site have resulted in a groundwater plume containing RDX that appears to emanate from the north/northeastern portion of the burning pad area.

Soils in the vicinity of the popping furnaces at Site L2 may be contaminated with RCRA characteristic hazardous wastes for cadmium (RCRA waste code D006) and lead (RCRA waste code D008). No RCRA hazardous wastes were identified in the groundwater at Site L2.

Site L2 is not located near a heavily populated area. The future land use for Site L2 is intended for development into the USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soils and groundwater at the site were stated to pose an unacceptable hazard to future recreational users. Final groundwater RGs were established in the ROD for the site. Once final soil RGs are designated for the USDA lands, remedial action activities will be conducted to clean up contaminated soil and remove existing UXO waste at the site. Remedial action activities are scheduled to occur during fiscal year 2006.

3.2.1.3 Site L3 (Demolition Area). Site L3 is located directly southwest of the Explosive Burning Grounds, Site L2. Covering approximately 50 acres, Site L3 is bounded on the west by Prairie Creek, on the south by an unnamed tributary to Prairie Creek, and on the east by Star Grove Cemetery (Figure 7-36). The principal operation conducted in this area was the open burning of combustible refuse and munitions crates. An air curtain destructor, which facilitates combustion while reducing particulate emissions, was constructed at the site but never used. In addition, uncontaminated solid waste and some potentially low-level explosives-contaminated solid waste were burned in this area. A 1-acre fire training area is also located at the site.

The burning area consisted of U- and L-shaped bermed areas and a burning cage, which is a concrete pad surrounded by a steel mesh cage used to contain the burning debris. During the Phase I RI, geophysical techniques used to clear UXO from work areas indicated the presence of buried metallic debris in and around the U- and L-shaped bermed areas. The fire training area consisted of a small depression enclosed by an earthen berm. The demolition pits (less than 1 acre) were heavily vegetated, which suggests no recent activities in this area.

A total of 185 cy (204.5 tons) of soil is estimated to require a remedial action for lead. The volume of soil requiring a remedial action at the fire training pit is assumed to include the top 6 inches of surface soil over the entire fire training area (approximately 75 by 125 feet) and totals an estimated 175 cy (227.5 tons). In addition, soil in the area east of the demolition pits requiring a remedial action is estimated to include an area of 25 ft^2 to a depth of 6 inches of surface soil, totaling 10 cy (13 tons).

Results of sampling of Site L3 indicated contamination of RDX and lead that exceed RGs in the western portion of the bermed area with an approximate surface area of 170 ft^2 from the western edge. Since samples from 2.5 feet in depth did not exceed RGs for explosives or metals, soil contamination over the 170 ft^2 area has been assumed to extend 1 foot below grade. The volume of explosives and metals-contaminated soil within the bermed area of Site L3 is estimated to be 1,070 cy (1,391 tons). In addition, UXO was identified in this area.

The berms located along Prairie Creek are contaminated with lead, chlordane, 2,6-DNT and phosphate above the RGs for these constituents. The berms are present within an area measuring approximately 800 feet along Prairie Creek and 300 feet wide in the northwest portion of Site L3. The entire area between Prairie Creek and the easternmost access road is presumed to be filled with metallic debris and other wastes, including UXO.

The extent of contamination in the berms along Prairie Creek appears to be related to the presence of fill material. Several assumptions were made to calculate fill volumes. Average berm heights are estimated to be 8 feet in the northern berms and 3 feet in the southern berms. The average depth of fill is estimated at 3 feet below ground surface in the northern area and 2 feet below ground surface in the southern area. The fill is believed to be deeper closer to Prairie Creek greater than 10 feet and pinches out east of the burning cage. The estimated volume of the material is 35,000 cy (45,500 tons). Site L3 may contain UXO, which are classified as RCRA characteristic wastes (RCRA waste code D003) because of their reactivity.

Two separate explosives-contaminated groundwater plumes are of concern for Site L3, groundwater downgradient of the burning cage and groundwater downgradient of the central bermed area. The RI investigations indicate that these two groundwater plumes are not connected. Groundwater downgradient of the burning cage (MW410) was found to contain only RDX, at a concentration 222.2 μg/L. The source of this contamination appears to be contaminated materials buried in the berms along the creek. RDX was detected in bedrock well MW412, located downgradient of the bermed area, at a concentration 77.9 μg/L.

No RCRA hazardous wastes were identified in the groundwater at Site L3.

Site L3 is not located near a heavily populated area. The future land use for Site L3 is intended for development into the USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soil and groundwater were stated to pose an unacceptable risk to future recreational users. Final groundwater RGs were established in the ROD. Once final soil RGs are established for the USDA lands, remedial action activities will be conducted to clean up contaminated soil and remove existing UXO waste at the site. Remedial action activities are scheduled to occur during fiscal year 2006.

3.1.2.4 Site L14 (Production and Storage Area). Site L14 is a 33-acre site located in the southwestern corner of the LAP Area, near Sites L15 through L19 (Figure 7-39). It was initially constructed to produce various types of fuses. Mercury fulminate, reportedly stored at Site L14, was loaded into the fuses in the assembly line building (Building 4-14). After 1945, Building 4-14 was used for repackaging smokeless powder. According to JOAAP personnel, a sump north of Building 4-5 periodically overflowed, resulting in soil contamination in this area.

Explosives contaminants of concern include TNT and RDX. The highest concentrations of explosives (total concentrations of approximately 55,000 μg/g) were detected in surface soil near the large sump north of Building 4-5. Explosives concentrations decreased with depth, but were detectable in the deepest samples collected (at 5 feet). Total explosives concentrations in soil samples from all other areas at Site L14 were below RGs. The total volume of affected soil and sediment at Site L14 is estimated to be 420 cy (546 tons). An additional 20 cy (26 tons) of structural concrete in the sump area is estimated for disposal. No RCRA hazardous wastes were identified at Site L14.

RDX is the primary explosive detected in groundwater at Site L14. The source of this contamination appears to be overflows and leaks from the sump north of Building 4-5.

No RCRA hazardous wastes were identified at Site L14.

Site L14 is not located near a heavily populated area. The future land use for Site L14 is intended for development into the USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soils and groundwater at the site were stated to pose an unacceptable hazard to future recreational users. Final groundwater RGs were established in the ROD. Once final soil RGs are established for the USDA lands, remedial action activities will be conducted at Site L14 to clean up contaminated soil. Remedial action activities are scheduled to occur at the site during fiscal year 2005.

3.2.2 GRU2, Explosives and Other Contaminants – MFG Area

GRU2, Explosives and Other Contaminants in Groundwater, is entirely in the MFG Area and consists of plumes emanating from sources in Sites M1 (Figure 7-41), M5, M6, and M7 (Figure 7-45). These plumes also extend beneath portions of Sites M8 and M13, although there are no suspected sources in those areas. Explosives plumes are present in the overburden and upper bedrock aquifers. Various metals were also identified in groundwater at several sites. Tetrachloroethene (PCE) was the only VOC identified in a sample from Site M8 in 1995. The following table lists the sites included in GRU2 and the estimated volume of impacted groundwater in the plumes at each site.

GRU 2 Sites (Explosives and Other Contaminants in Groundwater – MFG Area)

Sites	Subareas	Volumes (MG)
M1	Southern Ash Pile (explosives and antimony)	62
M5	Tetryl Production Area (explosives)	96
M6	TNT Ditch Complex (explosives and PCE)	96
M7	Red Water Area (explosives and antimony)	96
M8	Acid Manufacturing Area (explosives and PCE)	96
M13	Gravel Pits (explosives, cadmium and antimony)	96
Total		**542**

The following table lists exceedances of RGs as a function of Land Use for groundwater in GRU2.

Exceedances of RGs
for Groundwater in GRU2

MIDEWIN TALLGRASS PRAIRIE AREAS (USDA)			INDUSTRIAL PARK AREAS				
Sites		**M1**	**M5**	**M6**	**M7**	**M8**	**M13**
		Maximum Concentration Exceeding RGs (µg/l)					
	RG (µg/l) USDA						
Explosives							
1,3,5-TNB	5.1			240			15.5
2,4,6-TNT	9.5		16.7	2,600	9.5		12.9
2,4-DNT	0.42			3,200	200	9	126
2,6-DNT	0.42	.608	5.53	2,700	70	0.53	39
2-NT	1,000			21,000			
NB	51			81.8			
RDX	2.6			52.7	46		
Metals							
Antimony	24	31					38.7
Cadmium	50			162			56
Iron	5,000		42,000			48,000	
Organics							
Tetrachloroethene	25			150			
Affected Aquifers		GD, SB	GD	GD, SB	GD, SB	GD	GD
Contaminated Volume (MG), Total 542		62	96	96	96	96	96

Key: GD *glacial drift, shallow aquifer*
SB *shallow bedrock aquifer*

3.2.2.1 Site M1 (Southern Ash Pile). Site M1 is comprised of approximately 68 acres located in the southwestern part of the MFG Area (Figure 7-42). The Southern Ash Pile was used from 1965 through 1974 as a landfill for ash residues generated from the incineration of wastewater produced in the TNT manufacturing processes. The "red water ash" in the Southern Ash Pile is derived from K047-listed hazardous wastes. IEPA has notified the Army, by letter of July 24, 1998, that because the ash residues at Site M1 no longer exhibit the characteristic of reactivity (for which they were listed), they are no longer hazardous wastes under Illinois Administrative Code (IAC) 35 IAC 721.103(a)(2)(C).

The ash pile, measuring 800 feet by 450 feet, covers approximately 8 acres. The ash pile is 10 to 15 feet high and is estimated to contain 205,200 cy (266,760 tons). Upon closure, the ash pile was originally covered with polyvinyl chloride (PVC) barriers, 12 inches of fill, and 6 inches of topsoil. However, as a result of erosion, the ash pile was recovered in 1985 with an additional 12 inches of clay and 6 inches of topsoil. Due to continuing erosion, additional repairs to the ash pile cover were performed in 1993, and a temporary geosynthetic liner was installed by the USACE in 1996 as part of an interim action.

MWH conducted an inspection for the temporary geosynthetic liner on November 10, 1998 to assess the condition of the cover materials. At the time, it was noted that approximately 40 to 50 percent of the existing liner had been removed by high winds. Following direction from USACE, MWH prepared preliminary estimates of the cost to either repair or replace the existing cover system. Following an inspection conducted on December 17, 1998, it was decided that the existing cover system could not be cost effectively repaired and a replacement cover system should be installed.

Replacement cover installation and associated operation and maintenance (O&M) activities were conducted from April 27 to July 1, 1999. Activities included removing and disposing of the existing high density polyethylene (HDPE) geomembrane cover; regrading and compacting the soil/ash subgrade; installing a new geomembrane cover system; installing a cover anchor system; and completing associated work activities. Construction activities for the replacement cover are documented in the *Draft Final Construction Completion Report and Operation and Maintenance Plan, Site M1 Interim Cap (Montgomery Watson, November 1999).*

The source of the groundwater contamination appears to be constituents leaching from the ash placed at this site. The sulfate RG for groundwater has been exceeded at numerous monitoring locations, and the sulfate RG for surface water has occasionally been exceeded. In addition, 2,6-DNT was once detected in a sample analyzed from MW231 (2.72 μg/L, July 1988). Antimony has also been detected once above the RG at monitoring wells MW104, MW105, MW107, MW201, MW231, MW347, and MW351 during August 1991. Subsequent resampling for antimony during 1998 indicated no detections.

Because sulfate concentrations in compliance wells at Site M1 continued to exceed the groundwater RG, an Explanation of Significant Difference (ESD) was submitted by the

USACE on February 13, 2003. The ESD requested a modification to expand the northern boundary of the GMZ at Site M1. The ESD modification was approved, as proposed, during February 2003.

No RCRA hazardous wastes were identified at Site M1.

Site M1 is not located near a heavily populated area. The future land use for Site M1 is intended for development into USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soils were stated to pose an unacceptable risk, and groundwater was stated to pose an unacceptable hazard to future recreational users. Final groundwater RGs were established in the ROD. Once final soil RGs are established for the USDA lands, remedial action activities will be conducted at Site M1 to clean up contaminated soil and dispose of ash deposited at the site. Remedial action activities are scheduled to occur during fiscal year 2008.

3.2.2.2 Site M5 (Tetryl Production Area). Site M5 consists of approximately 244 acres located in the central portion of the MFG Area (Figure 7-46). The principal activity in Site M5 was the production of tetryl. Tetryl was manufactured during World War II, the Korean War, and again during the Vietnam War until 1973. The Tetryl Ditch (oriented from north to south) bisects Site M5 with Production Lines 1 through 6 located west of the ditch and Productions Lines 7 through 12 constructed to the east of the ditch. Lines 1 through 6 were burned and removed. The Nitrating ("East-West") Ditch lies immediately to the north of the nitrating buildings in the tetryl production lines.

Each of the 12 tetryl production lines consisted of four separate "houses," oriented north to south, for nitrating, refining, wet storage ("lag-house") and drying. Wastewater from the tetryl manufacturing processes in the nitrating and refining houses flowed into settling boxes located on the west side of the buildings. Wastewater from the settling boxes was discharged into open drainage ditches that flowed to the north into the Nitrating Ditch. The Nitrating Ditch drains into the Tetryl Ditch that ultimately drains into Grant Creek to the south of the Tetryl Production Area.

Wastewater from acid spills and daily floor cleaning was discharged from floor drains directly to the settling boxes at the nitrating and refining houses. Additionally, dust traps were constructed outside of the eastern doors of these buildings to collect tetryl residues.

The primary wastewater from the tetryl drying process was discharged to a settling box constructed immediately to the west of each drying house. A concrete weir was constructed in the Nitrating Ditch that formed a settling basin to the south of the acid recovery building for Tetryl Production Lines 7 through 12. Crystalline explosive compounds were visible in the basin sediment where wastewater from the AFR building and the nitrating buildings on Production Lines 10, 11, and 12 was collected.

Explosives COCs for soil at Site M5 included TNB, TNT, 2,4-DNT, tetryl, and 2,6-DNT. Results of sampling of Site M5 indicated contamination of Tetryl, TNT, 2,4-DNT, 2,6-DNT, lead, and beryllium that exceeded RGs.

Buildings in Site M5 West were removed in 1988, and the area was backfilled, regraded, and revegetated. Buildings in the Site M5 - East Area were demolished in 1998 in conjunction with the liquidation activities at JOAAP. Unlike Site M5 - West Area, the concrete floor slabs and footings within the Site M5 - East Area remained in place prior to MW's 1999 summer field activities. Also, various building debris components were left on site in and near these building features.

Remedial activities were conducted from July to November 1999. Approximately 1,500 cy (1,950 tons) of SRU1 soils and 4,100 cy (5,330 tons) of SRU3 soils were excavated from Site M5 and delivered to the Site M4 – Bioremediation Treatment Facility (BTF) for biological treatment and disposal. Confirmation sampling verified that remaining soils do not exceed the SRU1 or SRU3 RGs established in the ROD.

SRU1 and SRU3 soils above RGs from Site M5 have been excavated, screened, transported and successfully treated at the Site M4 - BTF to the RGs set in the ROD. Treatment results for SRU3 soils excavated from Site M5 can be found in the *Draft 2003 Bioremediation Report* (currently under construction). Treatment results for SRU1 soils can be located in the *Draft Treatment Completion Report – SRU1 Tetryl Soils* (MWH, February 2004).

Two groundwater samples collected from monitoring well MW207 during July 1988 contained 2,6-DNT and TNT at concentrations of 5.53 μg/L and 16.7 μg/L (Appendix C; Table C-1), respectively. MW207 is located in the north-central part of Site M5, near the junction of the East-West Ditch and the Tetryl Ditch. Wastewaters discharged into those ditches are the suspected source of the groundwater impacts. In addition to explosive compounds, iron was also detected at a concentration of 42,000 μg/l, which was above the established background level. Subsequent resampling for iron at MW207 indicated levels below the method reporting limit (100 ug/L).

No RCRA hazardous wastes were identified at Site M5.

Based upon future industrial use of Site M5, final soil RGs established in the ROD were determined using human health, risk-based models for industrial exposure. Based upon the baseline risk assessment, soils and groundwater were stated to pose a "hazard", and sediment was stated to pose a "risk" to industrial receptors. Following remedial activities, soils containing COCs above RGs were removed, thereby minimizing the risk to human health and the environment. Site M5 has achieved closure status as part of the SOU as documented in the *Final Site M5 Closure Report* (MW, December 2000).

3.2.2.3 Site M6 (TNT Ditch Complex). Site M6 covers approximately 271 acres, located in the central part of the MFG Area (Figure 7-46). During World War II, the production of TNT and DNT were the major activities at Site M6. The TNT production lines were again operated at full capacity for the Korean and Vietnam Wars. During each of the inter-war periods, the plant mission was changed to a research and development (R&D) role in which explosive compounds, such as nitroxylenes, were produced. TNT production ceased in 1977.

Twelve parallel TNT "batch" production lines were initially constructed in the TNT Ditch Complex from south to north. The principal buildings in each TNT production line were oriented east to west. The batch production lines were constructed in pairs; each line began with a "mono-house," then a "bi-house," followed by a "tri-house" for the nitration of toluene.

The TNT process wastewater ("red water") from each tri-house and wash house was initially discharged from wooden holding tanks to open clay-lined ditches that drained into the 9,100-foot long "TNT Ditch." The original wastewater drainage system, specific to the wash houses, was replaced in 1965 by a system of wooden flumes constructed in the TNT Ditch. The wash house red water was then diverted to the Red Water Area for treatment. The Red Water Area (Site M7) was constructed at the southern end of the TNT Ditch Complex.

DNT-contaminated wastewater from the bi-houses and DNT sweating-and-graining buildings was discharged via wooden settling tanks into open troughs and ditches that flowed directly into the stormwater sewer system and discharged into the TNT Ditch. Wastewater discharged directly to the TNT Ditch was not treated in the Red Water Area and flowed directly into Grant Creek.

Occasionally, operational problems developed during the nitrating processes. To avoid potential explosion hazards, the explosives batch in progress could be flooded with water stored in large wooden "drowning" tubs. During the period from March 16, 1972 through September 14, 1974, more than 30 instances were recorded in which batches of explosives were drowned. The batch drownings primarily occurred at the tri-houses during the final nitration step. Approximately 4,800 pounds of DNT "bi-oil," 5,600 pounds of Oleum, and 2,800 pounds of nitric acid were released to the TNT Ditch with each event. Similar drowning tubs were located at each bi-house.

Explosive COCs for soil at Site M6 include TNB, TNT, 2,4-DNT, 2,6-DNT, 2-nitrotoluene (2-NT), and RDX. Results of soil sampling at Site M6 indicated that TNT, 2,4-DNT, lead, arsenic, and beryllium exceeded RGs. The areas of contamination exceeding RGs include the TNT wash houses, bi-houses, tri-houses, between the wash houses, the TNT Ditch, the AFR Buildings, and the perimeter of the laboratory building. The volume of explosives and metals contaminated soil in the TNT Ditch is 12,000 cy (15,600 tons).

Soils at Site M6 may include the following RCRA characteristic wastes: soils contaminated with toxicity classification leaching procedure (TCLP) extractable 2,4-DNT (RCRA waste code D030) and soils contaminated with TCLP extractable lead (RCRA waste code D008). The soils at M6 may also contain RCRA-listed wastes if contaminated with red water (RCRA waste code K047) and DNT production waste waters (RCRA waste code K111).

In 1999, USACE authorized additional site investigations of locations within the Site M6 - North Area (Continuous Lines Area) which were not previously covered in the RI/FS but were suspected of containing soil contamination. The site investigation and characterization performed by MW, indicated that explosives contamination was limited to discrete locations and in suspected surface-level contaminated soil beneath the elevated red water discharge pipe. During the 2000 construction season, the explosives contaminated soil was excavated and stockpiled at the Site M4 - BTF for subsequent treatment. Post-removal action confirmation sampling indicated that soils in excavation areas satisfied RGs.

The main rail line and spurs are located on the eastern edge of Site M6 and extend the entire length of the site. The main rail line is approximately 6,000-ft long and has 35 rail spurs that run off at a slight angle to the southwest and are approximately 200 ft in length. The rail lines were salvaged for scrap in 1998 prior to initiation of RA activities by MW during 1999. At the discretion of USACE, MW conducted characterization sampling at rail lines and spurs at Site M6. Areas targeted for characterization by USACE were selected based on visual observations of stained soil and lack of vegetation. Based on the results of the 1999 characterization effort, USACE developed a comprehensive characterization plan in 2003 designed to locate and identify additional or outstanding explosives contaminated soil along the main rail line and spurs not identified during 1999 characterization sampling activities. Soil characterized above RGs was excavated and transported to the Site M4 - BTF for treatment.

Remedial activities have been conducted at Site M6 to address the soil COCs. Construction and sampling activities for the excavation and disposal of SRU1 and SRU3 soils were conducted at Site M6 during the 1999, 2002 and 2003 construction seasons. RA activities have resulted in the excavation of approximately 100,000 cy (130,000 tons) of SRU1 and SRU3 soils.

Seven explosives (RDX, 2,4-DNT, 2,6-DNT, nitrobenzene (NB), 2-NT, TNB, TNT) were detected with concentrations above the RGs in groundwater samples from Site M6.

The largest source of explosives in groundwater in Site M6 is the wastewater infiltration from the TNT Ditch. Other sources are soil-impacted areas associated with the production lines and the wastewater discharges into sewer lines. Until SOU remedial activities are completed, these sources will probably continue to release explosives to the groundwater.

According to the ROD, PCE was detected at a concentration of 150 μg/L in one sample above the RG and that the source appears to be related to a release in the former shop area of Site M6. No supporting documentation could be located confirming this detection. In addition, the location of the former shop area could not be confirmed. Additional monitoring for PCE at Site M6 has indicated no exceedances of the RG. A total of 26 wells at Site M6 have been sampled for VOCs since 1998 for a total of 107 VOC analyses conducted. PCE was only detected once at well MW313 at a level between the level of detection and level of quantitation. Subsequent resampling at MW313 indicated no detection of PCE.

According to the ROD, cadmium was detected once in a sample collected from MW123 in 1982 at a concentration (162 μg/L), which is higher than the RG. No supporting documentation could be located confirming this detection. No cadmium was detected at MW123 in a sample collected during June 1981.

No RCRA hazardous wastes were identified in the groundwater at Site M6.

Site M6 is not located near a heavily populated area. Site M6 is in the process of being transferred to the State of Illinois for inclusion into an industrial park. The northern portion of Site M6 has already been transferred to the State of Illinois, and subsequently to a private developer. Developments within the industrial park include an intermodal rail system with a rail spur, additional roadways for truck traffic, large areas reserved for warehouses, and a coal-powered power plant. Based upon future industrial use of Site M6, final soil RGs established in the ROD were based on human health risk-based models for industrial exposure. In the ROD, soils, groundwater, and sediment were stated to pose an unacceptable hazard, and surface water was stated to pose an unacceptable risk to future industrial users. Remedial activities are currently being executed to remove soil containing COCs above RGs. Remedial action activities are scheduled to be completed during fiscal year 2004.

3.2.2.4 Site M7 (Red Water Area). Site M7 covers approximately 49 acres located in the central part of the MFG Area immediately to the south of the TNT Ditch Complex (Figure 7-46). The TNT Ditch forms the eastern boundary of Site M7. Facilities within Site M7 include three separate groups of storage tanks, pumping stations, evaporators, and incinerators. Beginning in 1965, these facilities were used to treat wastewater ("red water") containing explosives residues and derivatives produced in the TNT manufacturing process. At that time, a wooden flume system was constructed, and the red water from the TNT wash houses was diverted from the TNT Ditch and conveyed by the wooden flumes. The red water was collected in storage tanks to the south of the TNT Ditch Complex. Overflow of untreated red water was stored in the Red Water Lagoon, located in the northern portion of Site M7. This 3.3-acre lagoon had a capacity of 4.1 million gallons and was remediated in 1985.

Explosive COCs for soil at Site M7 included TNB, TNT, 2,4-DNT, RDX, and 2,6-DNT. Soils at Site M7 were considered listed wastes if contaminated with red water (RCRA waste code K047) and DNT production wastewaters (RCRA waste code K111). The areas of contamination exceeding RGs included soils in the drainage areas located in the northwest portion of the Red Water Area.

During RA activities conducted from July through October 2001, approximately 16,923 cy (22,000 tons) of SRU1 explosives contaminated soils were excavated from Site M7 and delivered to the Site M4 - BTF for biological treatment and disposal. Confirmation sampling verified that remaining soils do not exceed RGs.

Four explosives (RDX, 2,4-DNT, 2,6-DNT, and TNT) were detected in groundwater samples from Site M7. The suspected source of the groundwater contamination is the infiltration of wastewater containing explosives compounds.

Site M7 is not located near heavily populated or environmentally sensitive areas. Site M7 is in the process of being transferred to the State of Illinois for inclusion into an industrial park. Developments within the industrial park include an intermodal rail system with a rail spur, additional roadways for truck traffic, large areas reserved for warehouses, and a coal-powered power plant. Based upon future industrial use of Site M7, final soil RGs in the ROD were based on human health risk-based models for industrial exposure. According to the baseline risk assessment, soils were stated to pose an unacceptable hazard, and surface water, groundwater and sediment were stated to pose an unacceptable risk to future industrial users. Following RA activities, soil containing COCs above RGs was removed. Thus, Site M7 has achieved closure status as part of the SOU as documented in the *Final Closure Report – Site M7* (MWH, November 2003).

3.2.2.5 Site M8 (Acid Manufacturing Area). Site M8 covers an area of approximately 304 acres in the central portion of the MFG Area (Figure 7-46). The shape of Site M8 is an inverted "L" oriented lengthwise from north to south. Site M8 contains four areas in which nitric and sulfuric acids were produced and combined into various strength "mixes" for use in the manufacturing of DNT, TNT, and tetryl.

Acid Area 3 is located in the northeast corner of Site M8. The production of Oleum, strong nitric acid, and other acids used in the production of explosives was the principal activity in Acid Area 3, which contained the Oleum Plant, the Northern Ammonia Oxidation Plant, and the Northern Acid Area. The Oleum Plant was located in the northern portion of Acid Area 3. The southern half of the Oleum Plant consisted of concrete and brick pads for the receiving and storage of bulk sulfur. Raw sulfur was readily apparent throughout this area and along the southern railroad spur. Sulfur is not a CERCLA regulated waste, and was not identified in the ROD as a risk.

On August 10, 2000, the site was transferred to the State of Illinois. Subsequent site activities include the construction of the intermodal rail facility currently operated by Burlington Northern Santa Fe (BNSF) Railroad. The site lies within the GMZ for Site M8, and ground water monitoring activities are currently conducted as part of the GOU long-term monitoring (LTM) plan.

The only exceedance of groundwater RGs for explosives at Site M8 occurred for 2,4-DNT in a sample collected from monitoring well MW325. 2,4-DNT was detected at a concentration of 0.531 μg/L during October 1991. Groundwater impacted by explosives at Site M8 is most likely due to leaching of isolated sources that have been largely depleted in the years since the facility was active.

No RCRA hazardous wastes were identified at Site M8.

Site M8 is not located near populated or environmentally sensitive areas. Site M8 was transferred to the State of Illinois for inclusion into an industrial park facility. Subsequent site activities have included the construction of an intermodal rail facility currently operated by BNSF. According to the *Finding of Suitability to Transfer (FOST), February 1999,* no exceedances of soil RGs were known at Site M8. Therefore, no remedial action was required prior to the land transfer.

3.2.2.6 Site M13 (Gravel Pits). Site M13 is located in the central portion of the MFG Area to the north of the Tetryl Production Area, to the east of the TNT Ditch Complex, and to the west of Acid Area 1 (Figure 7-46). The Gravel Pits cover approximately 106 acres.

Four potential disposal areas have been identified within Site M13. Each of the disposal areas in Site M13 has an area of less than 12 acres. JOAAP records and aerial photographs indicate that landfill activities at the Northern Gravel Pit began in 1966 and ceased in 1984. The topography in the vicinity of the Northern Gravel Pit is flat. The Northern Gravel Pit contains scrap metal, creosote-treated railroad ties and telephone poles, and a variety of construction and office debris. None of the other pits were identified as containing wastes posing potential threats to human health or the environment. Soil COCs at Site M13 include beryllium, lead, and benzo(a)pyrene. The material in the former disposal areas requiring remedial action is estimated to be 222,000 cy (288,600 tons).

Groundwater has been collected and analyzed for explosives and metals. Four explosives (TNT, 2,6-DNT, TNB, and 2,4-DNT) have been identified as COCs in groundwater at Site M13. Groundwater RG exceedances have occurred for 2,4-DNT and 2,6-DNT. In addition to the explosives, antimony was detected at MW322 at a concentration of 38.7 μg/L during October 1991, and cadmium was detected at MW126 at a concentration of 56 μg/L (the date is unknown). Both detections of metals exceeded their respective RGs. Subsequent resampling of monitoring well MW322 for antimony during July 1998 indicated a non-detect for antimony at a reporting limit of 5 ug/L. Monitoring well MW126 was sampled for cadmium during May 1981, September 1991, and July 1998. Cadmium was not detected above the detection limit in any of these analyses. The source of explosives and metals in groundwater samples may be infiltration of wastewater formerly conveyed in the TNT Ditch.

No RCRA hazardous wastes were identified at Site M13.

Site M13 is not located near heavily populated or environmentally sensitive areas. Site M13 is in the process of being transferred to the State of Illinois for inclusion into an industrial park. Developments within the industrial park include an intermodal rail system with a rail spur, additional roadways for truck traffic, large areas reserved for warehouses, and a coal-powered power plant. Based upon future industrial use of Site M13, final soil RGs established in the ROD were based on human health risk-based models for industrial exposure. According to the baseline risk assessment, no risks to industrial receptors were identified at Site M13. Remedial activities will be conducted at Site M13 to construct a new Subtitle D landfill cap at the site. Remedial action activities are scheduled to occur during fiscal year 2007.

3.2.3 GRU3, Volatile Organic Compounds - MFG Area

GRU3, VOCs in Groundwater, is entirely in the MFG Area and consists of separate toluene plumes emanating from sources in the western and central sections of Site M10 - Toluene Tank Farms, and of a benzene plume found at Site M3 (Figure 7-48). The toluene plumes at Site M10 were in the overburden (glacial drift) aquifer of both the western and central tank farm sections of Site M10 (Figure 3-4), and in the upper bedrock aquifer of the western tank farm section of Site M10 (Figure 3-3). The benzene plume at Site M3 is in the upper bedrock aquifer. The following table lists the sites included in GRU3 and the estimated volume of impacted groundwater in the plumes at each site.

GRU3 Sites (VOCs in Groundwater – MFG Area)

Sites	Subareas	Volume (MG)
M3	**Flashing Grounds**	**0** (1)
M10	**Western and Central Toluene Tank Farms**	**3**
Total		3

Note: (1) Volume estimate not made for Site M3. Benzene expected to be degraded below RG since 1991.

The following table lists exceedances of RGs for groundwater in GRU3.

Exceedances of RGs
for Groundwater in GRU3

MIDEWIN TALLGRASS PRAIRIE AREAS (USDA)				**INDUSTRIAL PARK AREAS**	
Sites		**M3**	**M10 Central**	**Sites**	**M10 West**
Maximum Concentration Exceeding RGs (µg/l)					
	RG (µg/l) USDA			**RG (µg/l) IND. P**	
Volatile Organic Compounds (VOCs)					
Benzene	5	15.8		25	
Toluene	2,500		19,600	2,500	20,000
Affected Aquifers		SB	GD		GD, SB
Contaminated Volume (MG), Total	3	0	1.5		1.5

Key: *GD* *glacial drift, shallow aquifer*
SB *shallow bedrock aquifer*

3.2.3.1 Site M3 (Flashing Grounds). Site M3 covers an area of approximately 66 acres located in the west central portion of the MFG Area adjacent to Grant Creek. Site features are depicted on Figure 7-48. From 1942 until 1988, the principal activity at Site M3 was the flash burning of equipment and demolition materials to remove explosive residues. The flash burning was performed at two primary locations within a 6-acre fenced area. An area of explosives-stained soil, where trucks were washed after dumping explosive materials, is located between the primary burning pads and a dumping area/pad.

Four additional burning pads, located to the south of the fenced area of Site M3, were identified in aerial photographs. Each of the secondary burning pads in the central portion of Site M3 is approximately 2 acres. Numerous craters, located adjacent to the burning pads, may be indicative of TNT block testing. Later photographs indicate that by 1953 the area containing these southernmost burning pads had been covered with a layer of soil, but portions of the pads are still visible.

Explosives COCs for soil at Site M3 include TNB, TNT, and 2,4-DNT. Based on the data collected at Site M2 and the non-intrusive nature of the flashing operation, the vertical extent of explosives that exceeds RGs is assumed to be limited to one foot. The total volume of impacted soil is estimated to be 400 cy (520 tons).

Approximately 150,000 of the 260,000 ft^2 of topsoil within the 6-acre fenced area of Site M3 are estimated to contain lead concentrations above the RG. Based on the non-intrusive nature of flashing operations, the vertical extent of lead is assumed to be limited to one foot. The volume of lead impacted soil in Site M3 exceeding the RG is estimated to be 5,600 cy (7,280 tons).

Soils at Site M3 may include the following RCRA characteristic wastes: soils with TCLP extractable 2,4-DNT (RCRA waste code D030) and TCLP extractable lead (RCRA waste code D008).

Groundwater samples have been collected from two monitoring wells at Site M3 (MW233 and MW352) and analyzed for VOCs (as well as explosives, anions, metals, and semi-volatile compounds). One well (MW233) contained benzene exceeding the RG during August 1991. However, subsequent resampling of monitoring well MW233 during July and December 1998 and June and October 1999 yielded no other detections of benzene. No other VOCs have been detected in groundwater at Site M3 exceeding RGs.

Currently, monitoring wells MW112 and MW113 at Site M3 are sampled as compliance wells for Site M7.

No RCRA hazardous wastes were identified in the groundwater at Site M3.

Site M3 is not located near a heavily populated area. The future land use for Site M3 is intended for development into the USDA Midewin National Tallgrass Prairie. According to the baseline risk assessment, soils at the site were stated to pose an unacceptable hazard to future recreational users. Final groundwater RGs were established in the ROD. Once final soil RGs are established for the USDA lands, remedial activities will be conducted at Site M3 to clean up contaminated soil. Remedial action activities are scheduled to occur during fiscal year 2005.

3.2.3.2 Site M10 (Toluene Tank Farm). Site M10 in the northern portion of the MFG Area contained three toluene tank farms. Each of the tank farms covered approximately 5 acres and was in use through 1976. Site features are depicted on Figures 3-3 and 3-4. Four above ground storage tanks (ASTs), each with a capacity exceeding 1 million gallons of toluene, were constructed in each tank farm. For the period of World War II, during which nitroxylenes were manufactured at JOAAP, xylenes were stored in two of the three tank farms. The specific tanks used for xylene storage are not known. In separate incidents in August 1968 and July 1971, lightning destroyed the northwestern and southwestern ASTs in the Western Toluene Tank Farm. An estimated 1.1 x 10^6 gallons of toluene were lost, and for the most part destroyed, in each of the explosions and subsequent fires. Spill records also indicate that an AST in the Central Toluene Tank Farm was struck by lightning in June 1971. The tank was not destroyed; however, an unknown volume of toluene was lost and destroyed.

Toluene was detected in two samples at the Central Toluene Farm from monitoring well MW224 at a concentration of 20,000 μg/L during July 1988 and 6,000 μg/L during December 1992. In the Western Toluene Tank Farm, toluene was detected in two samples from monitoring well MW220 at a concentration of 10,000 μg/L during July 1988 and 19,600 μg/L during October 1991. The presence of toluene in groundwater, but absence in soil, has been explained as the result of a high water table and thin overburden creating a flushing mechanism for the overburden. The suspected source is from the historical spills from tank ruptured after being struck by lightning.

VOC concentrations at Site M10 wells have been below RGs since 1998. Groundwater monitoring conducted at Site M10 during 1998, 1999, and 2000 at monitoring wells MW224 and MW220 indicated no detections of toluene. The Final Site M10 Closure Report was submitted in March 2003.

No RCRA hazardous wastes were identified remaining at Site M10. Previously, the toluene, which was used as a raw material or commercial chemical product, was identified as a listed RCRA hazardous waste (RCRA waste code U220).

Site M10 is not located near a heavily populated area. The future land use for the Central Tank Farm at Site M10 is intended for development into the USDA Midewin National Tallgrass Prairie. The West Tank Farm at Site M10 is in the process of being transferred to the State of Illinois for inclusion into an industrial park. Final groundwater RGs were established in the ROD. Once final soil RGs are established for the USDA lands, no further action should be necessary at Site M10.

3.2.4 GOU No Further Action Sites

Fifty-three sites, plus three subareas suspected as having groundwater contamination, were investigated during the RI/FS and Risk Assessment process. The groundwater underlying 41 of these sites and the three subareas was determined to have either no contamination, no historical evidence suggesting potential contamination, or contaminant concentrations that do not pose a threat to human health or the environment. IEPA and USEPA agreed that, under CERCLA requirements, no further cleanup actions are required for these sites.

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4.0 REMEDIAL ACTIONS

The ROD for JOAAP was signed in October and November 1998. Remedial action objectives (RAOs) presented in the ROD were developed as a result of RI/FS activities conducted at the site. Data and cost estimates from RI/FS activities aided in the development and screening of remedial alternatives considered in the ROD. The primary objective of the remedial actions at JOAAP is to effectively mitigate, minimize threats to, and provide adequate protection of human health and the environment. To meet this objective, RAOs were developed for the SOUs and GOUs. The objectives of the final remedial actions are summarized as:

- Cleanup contaminants to the site-specific and chemical-specific RGs,
- Prevent human and environmental exposure to concentrations above the RGs,
- Eliminate soils as a continuing source of impacts to groundwater,
- Prevent migration of contaminants, and
- Remove characteristically hazardous RCRA wastes, except those contained within the capped landfills of SRU6.

The objectives of the interim remedial actions are summarized as follows:

- Eliminate soils as a continuing source of impacts to groundwater, and
- Prevent migration of contaminants.

The ROD presented selected final remedies for the SOU and GOU. Appropriate final remedial actions for future USDA soils have been developed, evaluated, selected, and presented in the *Proposed Plan for the Soil Operable Unit, Interim ROD Sites* (U.S. Army, February 2004). The selected remedies for interim sites will be formerly presented and approved by the appropriate regulatory agencies in accordance with the NCP, once the Final ROD for interim sites has been submitted. The submittal date for the Final ROD for interim sites is expected to be during fiscal year 2004. Site specific information describing remedy implementation, system operations, and O&M are described in detail in further subsections.

4.1 REMEDY SELECTION

The ROD for JOAAP recently underwent numerous internal modifications in an effort to address comments from the USDA in regard to the land intended to be transferred for reuse as the Midewin National Tallgrass Prairie. Resolution of these issues is not yet available.

In an effort to proceed with site cleanup in a timely manner, the ROD was reformatted and resubmitted for signature by the Army and USEPA with interim guideline status for the SOU sites located on land intended for future transfer to the USDA. These changes did not directly affect the GOU sites and did not affect the implementation of the LTM plan.

The SOUs were divided into seven SRUs, the GOUs were divided into three GRUs, and there were also two no further action (NFA) groups. Six SRUs involved CERCLA based remediation, one SRU involved non-CERCLA based removal action, and one SRU involved NFA sites for soil. Three GRUs involved CERCLA based action, and one GRU involved NFA sites for groundwater.

The final cleanup goal of the SRUs and GRUs was to protect human health and the environment by eliminating, reducing, or controlling hazards posed by the site. The goal of interim actions was to remove sources of groundwater impacts and/or prevent further migration of contamination.

The major components of the remedies selected in the ROD for soils include the following:

- **Excavation, bioremediation treatment of soil, confirmatory sampling, and reuse or disposal** – Explosives in soils at concentrations greater than RGs at SRU1 and SRU3 will be excavated, treated, and disposed of or reused. Confirmatory sampling must demonstrate that concentrations are below RGs, are not hazardous under RCRA, and do not exceed Land Disposal Restrictions (LDRs).

- **Excavation, confirmatory sampling, and disposal** – Metal contaminants in soils at concentrations greater than RGs at SRU2 and SRU3 will be excavated and disposed. Confirmatory sampling must demonstrate that concentrations are below RGs, are not hazardous under RCRA, and do not exceed LDRs.

- **Excavation, confirmatory sampling, and disposal** – PCB contaminants in soils at concentrations greater than RGs at SRU4 will be excavated, confirmatory sampled, and disposed. Disposal options are based on concentrations of PCBs (less than 50 mg/kg or greater than 500 mg/kg) in the removed soil.

- **Excavation, confirmatory sampling, and disposal** – Organic contaminants in soils at concentrations greater than RGs at SRU5 will be excavated and disposed. Confirmatory sampling must demonstrate that concentrations are below RGs, are not hazardous under RCRA, and do not exceed LDRs.

- **Excavation, waste segregation, and disposal** - Three landfills at SRU6 will include excavation of contaminated soil, waste segregation, and disposal.

- **Landfill Capping** - Three landfills at SRU6 are to be capped with new landfill covers.

- **Excavation and recycling or disposal -** Raw sulfur buried at two sites at SRU7 will be excavated and recycled or disposed.

- **No further action -** Twenty-eight sites at JOAAP suspected of having soil contamination have been determined to contain either no evidence of contamination or concentrations that do not pose a threat to human health and the environment. These sites require no further cleanup actions.

The remedial alternatives presented in the ROD for the GOU included no action, limited action, and pump and treat alternatives. Forty-three sites at JOAAP suspected of having groundwater contamination have been determined to contain either no evidence of contamination or concentrations that do not pose a threat to human health and the environment. These sites require no further cleanup actions.

The limited action alternative was chosen for the three GRUs in the GOU. Under the limited action alternative, steps are taken to prevent or limit the likelihood of human consumption or exposure to impacted groundwater, and natural attenuation is used to lower the concentrations of COCs in groundwater. The limited action alternative includes the following:

- Establish GMZs,

- Deed and zoning restrictions,

- Periodic site inspections,

- Groundwater and surface water monitoring, and

- Natural attenuation.

Natural attenuation involves the use of natural processes such as biological degradation, sorption, dispersion, and dilution to reduce the concentrations of COCs in the plumes. Source removal is required at the GRUs where soil contamination exists at concentrations greater than RGs. These sites and activities are described in the SOU RD/RA Workplan and the progress towards the SOU RAOs is described in the SOU First Five-Year Review Report. Monitored natural attenuation has been recognized as a cost-effective remedy for numerous federal and private facilities and has been accepted by the Army, the USEPA, and the IEPA as the best alternative for groundwater cleanup at JOAAP.

4.2 REMEDY IMPLEMENTATION

The remedial design for the SOU remedial activities was conducted between July 1998 and April 1999. The *Final Soils Operable Unit Remedial Design/ Remedial Action Workplan – Phase 1 (MWH, 1999)* was approved and signed on April 7, 1999. Several factors governed the order in which remedial activities were conducted. The sites that posed the highest risk to human health and the environment, based upon the risk assessment, were generally the sites where remedial activities were first initiated. Other factors affecting the order of remedial activities included:

- Mitigation of the highest potential for migration of COCs from soil to groundwater,
- Expedition of property transfers, and
- Budget considerations.

Within the SOU, 24 sites were investigated and grouped into seven SRUs according to the type of contamination found. The seven SRUs have no direct correlation with the three GRUs. Because multiple types of soil contamination occur at individual sites, the same site may have more than one SRU designation.

The seven SRUs and the selected remedial action are as follows:

- SRU 1 Explosives in Soil - Bioremediate and dispose,
- SRU 2 Metals in Soil - Excavate and dispose,
- SRU 3 Explosives and Metals in Soil - Bioremediate and excavate/dispose,
- SRU 4 PCBs in Soil - Excavate/incinerate and dispose,
- SRU 5 Organics in Soil - Excavate and dispose,
- SRU 6 Landfills - Contain or excavate and dispose, and
- SRU 7 Sulfur – Excavate and dispose.

The relationship of the various SRUs to the GRUs is complex given that sites may be grouped into multiple SRUs. Not all soil sites have corresponding groundwater contamination, and some groundwater sites do not have soil contamination. As a result, most discussion and operational information in this report was recorded, evaluated, and presented in terms of the specific sites. Source removal is an important component of natural attenuation for groundwater remediation at most of the sites. The specific activities are described in the SOU RD/RA Workplan. Because the SOU remedial actions are ongoing, limited discussion is provided.

The remedial design for the GOU was conducted between July 1998 and April 1999. The *Final Groundwater Operable Unit Remedial Design/Remedial Action Workplan (MW, 1999)* was approved and signed on April 8, 1999. The primary objective of the cleanup of the GOU at JOAAP is to effectively mitigate contamination, minimize contaminant threats, and provide adequate protection of human health and the environment. The combination of the monitored natural attenuation groundwater remedy and source removal of impacted soils for the MFG and LAP Areas are expected to meet the RAOs.

4.3 SYSTEM OPERATIONS/OPERATION AND MAINTENANCE (OM&M)

The remedy has been implemented without major modification, except at Site M1, where an ESD was necessary. The ESD expanded the northern and western boundaries of the GMZ as shown on Figure 7-42. The expanded GMZ area consists of approximately 49 acres on pastureland previously transferred to the USDA for intended future use as tall grass prairie. In conjunction with the change in the GMZ boundary, the early warning and compliance wells were reassigned. The new boundaries should allow the groundwater remedy (natural attenuation) to proceed without additional exceedances of the sulfate RG at, or beyond, the GMZ limits.

Periodic maintenance of the groundwater monitoring network has occurred at JOAAP. Due to the development of the Deer Run Industrial Park within the MFG Area, 26 monitoring wells were abandoned after the Spring 2001 sampling round. The abandonment of these wells was performed during March, April, and May 2001. Eighteen of these wells were part of the LTM Program. Harbour Contractors subcontracted RD-n-P Drilling to replace and develop the eighteen wells during September and October 2001. A geologist from STS Consultants, Ltd. and MWH performed oversight on the replacement well installations. Replacement wells are labeled using the original well name followed by a "R" which designates it as a replacement well. The eighteen replacement wells were designated as:

MW114R	MW123R	MW125R	MW127R	MW147R	MW148RR
MW162R	MW166R	MW207R	MW320R	MW323R	MW324R
MW325R	MW327R	MW354R	MW355R	MW356R	AEHA14R

In addition to the eighteen well replacements, four monitoring wells (MW662, MW663, MW664, and MW665) were added at Site M6 to monitor groundwater around a large sedimentation basin installed as part of the land redevelopment (Figure 7-46). Replacement monitoring wells were installed as water table, combined, or bedrock wells. Water table wells have screens intersecting the water table usually within unconsolidated deposits, combined wells have screens intersecting unconsolidated and bedrock stratographic units, and bedrock wells are screened within bedrock.

Additional well abandonment and replacement activities took place at Site M13 from January 12, 2004 through January 21, 2004. As part of the on-going development of the Deer Run Industrial Park, excavation activities at Site M13 resulted in the damage or destruction of monitoring wells GC3, GC4, M2, M3, MW126, MW345, and MW346. Monitoring wells M2, MW126, and MW345 were abandoned, but damaged monitoring wells GC3, GC4, M3, and MW346 at site M13 could not be located for abandonment. Replacement wells consisted of two well nests, each with an overburden well and a shallow bedrock well. One of the well nests was installed at the former MW126 location (MW126R/MW362) and the other well nest was installed near the former MW345 location (MW363/MW364). Well abandonment and replacement well locations have been included on Figure 4-1.

Costs for system operation are summarized in Table 4-1. The cost to implement the monitored natural attenuation remedy since inception in June 1999 through this First Five-Year Review has been approximately $1,663,500.00.

5

5.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

This was the first Five-Year Review for the GOU at JOAAP.

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6

6.0 FIVE-YEAR REVIEW PROCESS

6.1 ADMINISTRATIVE COMPONENTS

Representatives from the USEPA and IEPA were notified of the initiation of the Five-Year Review through project management meetings conducted monthly at the JOAAP site office. Ms. Diana Mally of the USEPA and Ms. Nicole Wilson of the IEPA assisted in the review as representatives for the regulating agencies. Discussion with the community and interviews pertaining to the Five Year Review were conducted during the Restoration Advisory Board (RAB) meeting held at City Hall in Wilmington, Illinois.

The First Five-Year Review of the GOU at JOAAP was conducted between October 2003 and January 2004. The review team included members from the MWH project management and technical advisory staff with expertise in construction management, engineering, hydrogeology, chemistry, environmental regulations, and risk assessment. Components of the Five-Year Review are discussed below.

6.2 COMMUNITY INVOLVEMENT

Activities to involve the community in the First Five-Year Review were initiated through interviews and discussions conducted during RAB meetings held at City Hall in Wilmington, Illinois. The RAB meetings are held on a bi-monthly basis and are voluntarily attended by members of the surrounding communities and other potentially interested parties. These meetings serve as the main contact point for interested parties in the community to discuss the historical, current, and future site operations at JOAPP. Members of USACE, USEPA, IEPA, and MWH, are present at the RAB meetings to answer questions posed by those attending. The RAB board consists of twelve people representing seven communities from the surrounding area.

Notification of the commencement of the Five-Year Review was given to the community during the RAB meeting conducted on January 7, 2004. The content and purpose of the Five-Year Review was discussed in general during the meeting, and in detail during interviews with the RAB co-chair, Reverend Alan Abbott, where the discussion was directed toward the impacts on, and concerns of, the community in relationship to the historical, current, and future activities at the site.

6.3 DOCUMENT REVIEW

The First Five-Year Review consisted of a review of relevant documents including remedial design reports, closure reports, work plans, O&M records, facility records, and the ROD. A list of documents that were reviewed during the First Five-Year Review is presented in Appendix B.

Literature was also searched during the Five-Year Review process to determine if more information was available on first order decay rate coefficients for explosives compounds. Recent laboratory column studies to determine the first order decay rate coefficient for RDX have been performed by the USACE Engineer Research and Development Center (USACE – August 2003). In particular, laboratory column tests were run at three different temperatures (5, 10, and 15 degrees Centigrade (^{o}C)) to determine the decay rate of RDX. The first order decay rate coefficient (k) for RDX varied between $1.14X10^{3}$ yr^{-1} to $1.63X10^{3}$ yr^{-1} for the three treatment columns, with an average k value of $1.36X10^{3}$ yr^{-1} (standard deviation of 0.019). It was determined that aquifer temperature has a significant influence on the in-situ biodegradation of RDX. For the experimental conditions of the USACE tests, an activation energy of about 63.54 kilojoules/mole (kJ/mol) for RDX was estimated. As described in the sections below, first order decay rate coefficients used in modeling for JOAPP are magnitudes of order less than those values obtained from these recent studies. Since the preparation of the GOU RD/RA Workplan, no other recent literature was found for the biodegradation of explosive compounds detected at JOAAP.

Applicable groundwater standards, as listed in the ROD, were also reviewed.

6.4 DATA REVIEW

Baseline groundwater monitoring was conducted during the summer and fall of 1998 as part of the RD for the GOU. Previous groundwater analytical data had been collected during the many phases of RI work conducted at the site. Since the implementation of the GOU RD/RA Work Plan, semi-annual groundwater monitoring has been conducted at JOAAP as part of the monitored natural attenuation remedy. The first semi-annual groundwater monitoring event occurred during June 1999. Subsequent sampling has routinely occurred during May and October of each year. Groundwater analytical data pertaining to JOAAP from RI through LTM have been entered into a database. Data used to produce tables and determine trends for the Five-Year Review have been generated using the database. Historical data summary tables for explosives, VOCs, and indicator parameters (including sulfate) are presented in Appendix C.

Because of specifications in the GOU RD/RA Workplan (Montgomery Watson, 1998) and requirements in the ROD, the methods described in the following subsections were used, including trend analysis, first order rate decay determinations and BIOSCREEN modeling. Specifically, the ROD required that a groundwater model be developed to determine if GMZs assigned to GOU sites would be appropriate. The BIOSCREEN model was chosen at the RD/RA Workplan preparation stage and is used in this analysis to evaluate travel distances. The ROD also called for using site analytical data to predict estimated clean-up times for GOU sites. Plotting site data and applying exponential curve fitting is a standard method to calculate first-order rate decay constants and predict estimated clean-up times. In addition to these methods, the Mann-Kendall test was also used to provided a statistical trend analysis of concentration data collected during the Five-Year Review period.

The Five-Year review process usually is applicable to sites in which SOU RA activities have been completed, but SOU RA activities have only been conducted at three of the ten (M5, M6, and M7) GOU sites proposed for source removal and one of the three (M6) is ongoing. Nonetheless, data was analyzed for all GOU sites in a good faith attempt to determine if the chosen remedy is effective at the each GOU site. The chosen remedy of monitored natural attenuation (MNA) will be considered to be functioning as designed in the ROD as long as contaminant concentrations in groundwater are not exceeding RGs at points of compliance for site GMZs and institutional controls prohibit the withdrawal and consumption of contaminated groundwater.

6.4.1 Trend Analysis

Semi-annual groundwater sampling has been conducted since the baseline sampling event during summer and fall 1998. Explosive compound data were used to produce figures that show graphs of selected COC concentrations versus time. These graphs present temporal trends in groundwater quality to assess the effectiveness of natural attenuation at each of the sites. Compounds to be assessed were selected based on the COC with the greatest concentration relative to its RG. If more than one well was available at a site for trend analysis, wells were preferentially selected where RG exceedances were the greatest. These steps provided conservative data sets from which estimated COC reduction rates may be used to project site clean-up times. Trend graphs are presented as Figures 6-1 through 6-21. Specific trends for each site are discussed in the appropriate subsections of Sections 7.2 through 7.4. The estimations of projected site clean-up times are discussed in the following section.

6.4.2 Estimated Clean-up Time Calculation

The projected site clean-up times for specific COCs are based on trend analyses to estimate reduction rates at selected wells for individual sites. Estimates of COC reduction rates are determined by fitting an exponential curve through each graph produced in the trend analysis performed in Section 6.4.1. The exponential model (y=exp(x)) is the typical governing equation describing first-order biological degradation (C/C0 = exp(-kt)) and is the model used by most contaminant transport models to describe the biological degradation component of the transport equation (EPA, 2002, Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies. EPA/540/S-02/500). Where data are sparse and no distinct trend is apparent, an exponential curve was used to maintain consistent results. The origins of the exponential curves were fit through the data beginning at the maximum observed concentration. The exponential curves were also not fit through anomalously low concentration values. Each of these measures act to produce a conservative estimate and prevent the exponential curve from being skewed downward and artificially reducing the calculated site clean-up timeframes.

Graphs and curve fitting analyses for determining first order decay rates are presented in Appendix E. Note that graphs were created using Julian time with January 1, 1950 as the presumed first day COCs reached groundwater.

The graphs used to estimate projected clean-up time have R^2 values displayed. The R^2 value is an indicator of how well the equation for the fitted exponential curve represents the observed data. An R^2 value equal to 1.0 is an exact fit, and values that approach zero suggest a very poor fit. For this analysis, R^2 values were generally low because of large variability in the observed data. Clean-up times calculated from trend analyses that have exponential curves with R^2 values closer to zero than one will likely be less reliable. Plotting site data and applying best-fit exponential curve is a standard way to calculate first-order rate decay constants and predict estimated clean-up times. More reliable estimates of first order decay rate constants and predicted clean-up times will be accomplished when soil source control measures have been implemented at each site. Once soil source controls measures are completed, non-linear loading to groundwater should cease and groundwater concentrations will become less variable. R^2 values have been included on trend analyses presented as Figures 6-1 through 6-21. For additional information regarding this analysis and an example calculation for projected clean-up times, refer to Appendix D. A summary of projected clean-up times is presented in Table 6-1.

Projected cleanup times are only approximations based on conservatively estimated COC reduction rates. The target concentration used to calculate the cleanup time for site remediation is the compound-specific RG. The calculated clean-up time is for a specific compound to attenuate below its RG. The COC reduction rate includes the physical, chemical, and biological attenuation mechanisms active within the aquifer. Discussions of specific site clean-up times are included in the appropriate sub-sections of Sections 7.2 through 7.4.

6.4.3 Mann-Kendall Analysis

Data obtained from LTM since baseline sampling conducted during 1998 were evaluated using the Mann-Kendall analysis. Previous RI data was not used in this analysis because the test is set up to analyze data from the ten most recent monitoring events without a time-lapse between events. The Mann-Kendall analysis is a nonparametric statistical test used to show whether groundwater contamination concentrations in a monitoring well are increasing, stable, or decreasing. The test is not able to determine the rate at which concentrations are changing over time. The Mann-Kendall Test is not valid for data that exhibit seasonal behavior. For data exhibiting seasonal behavior, testing only data from the seasons with the highest contaminant concentrations produces valid results. To demonstrate that natural attenuation is effective, the statistical test must show decreasing contaminant concentrations at an appropriate confidence level. The Mann-Kendall analysis gives a result with an 80% and 90% confidence level. The test also concludes if the detections in a well are stable if no trend exists at an 80% confidence level.

The Mann-Kendall analysis does not take into account the magnitude of scatter in the data. A data set with a great deal of scatter may return a Mann-Kendall analysis indicating there is no trend, when, in fact, no conclusion can be drawn regarding the trend because of data variability. In this case, additional data collection may be necessary to determine that the plume is stable, declining, or increasing. As a simple test, the coefficient of variation (CV) can provide an indication of the scatter in the data. The CV should be less than or equal to 1 to indicate that the no-trend hypothesis also indicates a stable plume configuration.

The Mann-Kendall spreadsheet used to evaluate JOAAP groundwater data was obtained from the Wisconsin Department of Natural Resources website (www.dnr.state.wi.us/). As was done during the trend analysis, the Mann-Kendall Test was performed on data from wells exhibiting the highest concentration at each site. Groundwater analytical data and groundwater elevation data were plotted to determine if seasonal variability in the data was apparent. Data from wells exhibiting seasonal variation were reanalyzed using the data with the highest concentrations. Mann-Kendall analyses are presented in Appendix F. Original Mann-Kendall analyses for wells exhibiting seasonal variability have also been included for comparative purposes. Discussions of Mann-Kendall analysis results by site have been included in the appropriate sub-sections of Sections 7.2 through 7.4.

Because the majority of contaminant mass at a site is associated with wells exhibiting the highest concentrations, the trends exhibited by these wells will provide an indication to what is happening near the contaminant sources at each site given the stage of remediation (First Five-Year Review). Decreasing trends in general, but especially near a source that has yet to be actively addressed, will indicate the likelihood that natural attenuation is occurring. An increasing trend near a source usually indicates additional source loading to groundwater and consequently a growing plume; however in this case, increasing trends at wells near sources are expected because removal activities that are currently ongoing or recently completed will have likely mobilized contaminants causing spikes in groundwater concentrations. The use of the Mann-Kendall test was limited to the same wells used in the other analyses for consistency in reporting results.

6.4.4 Modeling

Evaluation of appropriate groundwater model types was completed for JOAAP groundwater sites. Although three different model complexities were identified and discussed in the 35% Groundwater RD Report, the site-specific plume information, expected data output, and perceived data usage affected the model selection. Ultimately, one groundwater model was identified as being capable of providing information to justify monitored natural attenuation through enumeration of expected transport distance from known contaminated well locations.

For the purposes of the RD, and now during the Five-Year Review process, BIOSCREEN is used to predict the distance the plume will extend from the source area(s) at each site. The most contaminated monitoring well at each site was chosen to identify the distance from the suspected source to the GMZ. Iterative model runs were completed to evaluate the potential for contaminant migration in excess of RGs to locations at or beyond site GMZs. BIOSCREEN modeling run results for this Five-Year Review have been included in Appendix G.

The assumptions necessary for model inputs are extremely conservative and, therefore, the predicted distances of RG exceedances are likely much further from the source than what sampling results have actually shown them to be. For example, the input for source half-life was set as infinite, even though sources at JOAAP are likely to be removed within the next four years. Other examples of conservatism in the model include no retardation factors being applied, despite favorable site conditions for retardation, and for many of the sites, no decay coefficient was incorporated into the model.

During the RD, decay coefficients incorporated into model runs were for RDX and TNB and were obtained from the Waterways Experiment Station (WES) report that evaluated the feasibility of natural attenuation at Site L1 (WES, 1998). Decay constants that were incorporated into the current BIOSCREEN analysis were obtained from projected clean-up times calculated in Section 6.4.2. A summary of the modeling results and first order decay rate constants is presented in Table 6-2. In addition, Table 6-2 includes the distances that COCs may travel before concentrations are predicted to attenuate to the RG.

Discussions of BIOSCREEN modeling results by site have been included in the appropriate sub-sections of Sections 7.2 through 7.4.

6.5 SITE INSPECTION

A site inspection was conducted by MWH as part of the annual groundwater monitoring event conducted from October 7, 2003 through October 28, 2003. The purpose of the inspection was to assess the protectiveness of the remedy. Site inspection activities included monitoring well inspection for condition, functionality, and security. In addition, institutional controls implemented at sites were inspected or reviewed. A summary of implemented institutional controls for GOU sites has been included in Table 7-10. Fences were inspected at sites L1, L2, L3, L14, M1, and M8 to ensure restricted access is maintained. Security patrols were encountered numerous times during the three week period. Site operations at transferred properties at sites M5, M8 and M13 include fencing around the perimeter and have security check points at main entrances. Water used at new facilities is supplied by the town of Elwood. The following observations were noted during the site inspection:

- Grass and brush trimming should be conducted around monitoring wells to maintain well visibility for sampling and well protection.

- Monitoring well MW171 at Site L1 continues to be dry. The well has not been sampled since 1991.

- Monitoring well M2 at Site L3 has been damaged, and the well casing is severely kinked. No samples can currently be collected from the well.

- Monitoring wells GC3, GC4, M2, M3, MW126, MW345, and MW346 at site M13 have been damaged or destroyed by development activities. The damaged or destroyed monitoring wells were replaced by two separate well nests (MW126R/MW362 and MW363/MW3564) during January 2004 (Figure 4-1). One well nest was installed near former well MW126 and the other near former well MW345. Monitoring well abandonment and replacement activities occurred during January 2004.

- The gate in the fence along the south side of Site L3 is no longer attached to the hinges and is lying on the ground adjacent to the gate opening.

The institutional controls that are in place include prohibitions on the use or disturbance of groundwater until clean-up levels are achieved and any other activities or actions that might interfere with the implemented remedy. Deed restrictions have been filed for land transferred at Sites M5, M8, and M13. No activities were observed that would have violated the institutional controls. No unauthorized uses of groundwater were observed. Please refer to the SOU First Five-Year Review Report for Site M1 cover inspection documentation.

In accordance with the documents that transferred industrial property with restrictions and covenants, the current land owner submits an annual letter attesting that no violations of same have occurred. This letter is written to the Army, but also distributed to the USEPA and IEPA. A copy of the most recent report is presented in Appendix J to demonstrate that the reports are received. The report often covers subject matter not related to the restrictions, as well. These non-relevant portions of the letter have been blackened. Table 7-10 identifies the properties that are covered by the land owner letter certifying compliance with institutional controls.

6.6 INTERVIEWS

Interviews were conducted with appropriate parties affiliated with the JOAAP project and sites.

An interview was conducted on January 7, 2004 with the RAB co-chair, Reverend Alan Abbott. Discussion was directed toward the impacts on, and concerns of, the community in relationship to the historical, current and future activities at JOAAP. Interview comments are summarized below:

- The community is concerned about the future increased truck traffic affiliated with the opening of the Will County Landfill. Additional streetlights will be installed to compensate for the increased traffic.

- A concern was raised about the site security and lack of access restrictions. Rev. Abbott felt that all terrain vehicle (ATV) users can enter areas where remedial activities are active. Current site restrictions may not be stringent enough to be protective of the community.

- A comment was raised about the formulation of RGs as pertaining to USDA workers. Rev. Abbott made a comment that this issue forced a revision in RGs as the interim ROD was being developed.

- Reports give a comprehensive view of site operations, but site visits, presentations, slide shows, and pictures are more effective means of communication to the public about the on-going site operations at JOAAP.

- Rev. Abbott highly commended the project teams and regulatory staff for the effective execution and teamwork since the start of operations at JOAAP.

A copy of the interview questions and responses from Rev. Abbott are included in Appendix A.

An interview was also conducted with JOAAP Site Manager, Mr. Arthur Holz. The interview was conducted in the form of a hard-copy handout of interview questions developed for the Five-Year Review. Interview questions/discussion were directed toward the performance and management of the JOAAP project. Comments/responses from the handout are summarized below:

- In the first five years, this project has met or exceeded expectations. As compared to projections made in FY-2000, the project has reduced the expected Cost-to-Complete by over $29M and shortened the project life by three years.

- The project has met with some unforeseen difficulties. Bioremediation of DNT-contaminated soil has taken far longer than expected. The volume of contaminated soil requiring excavation at Site M6 is far greater than anticipated. Each of these adversities have been overcome and the project has remained on track.

- The bioremediation technology has been under constant improvement. The per-unit cost of treating soil has been reduced by more than 50% over the 4 plus years of operation.

- This project team has functioned very well. Outside observers have been impressed with the progress that we have accomplished and the successful way in which we have established positive working relationships among the parties.

A copy of the interview questions and responses from Mr. Holz are included in Appendix A.

7

7.0 TECHNICAL ASSESSMENT

The following are responses to three technical assessment questions posed by the *Comprehensive Five-Year Review Guidance* (USEPA, June 2001) regarding the monitored natural attenuation remedy for the GOU. A discussion of criteria most relevant to assessing natural attenuation is followed by a site-specific assessment. Site-specific information is presented in Sections 7.2 through 7.4 of this report. Water level information and interpreted flow directions have been derived using data collected during the October 2003 monitoring event.

7.1 NATURAL ATTENUATION PROCESSES

The natural attenuation process is influenced by site specific factors such as geology, hydrogeology, chemistry, and biological reactions. A discussion of each of these criteria and other factors influencing natural attenuation processes is presented below.

7.1.1 Geology

Significant geologic variables that impact natural attenuation are the characteristics associated with lateral and vertical heterogeneity of each aquifer. Factors that will be used to evaluate lateral and vertical heterogeneity include the composition and variability of material within an aquifer and the number of aquifers in which contaminants have been detected. To evaluate these factors, the regional and local geology were considered, and the significant variations were identified at each location. Laterally, within an unconsolidated aquifer, a large amount of heterogeneity is often due to glacial or fluvial depositional sequences that vary in direction, energy, and duration. This variability is evident in reviewing site cross sections (Figure 7-1 through 7-27). Lateral heterogeneity in bedrock is primarily due to fracturing. Vertical heterogeneity within unconsolidated deposits is primarily due to layering of different geologic units (i.e. outwash over till or fluvial sands over clays). Vertical heterogeneity within bedrock is due to layering, weathering, and fracturing. The following text is a summary of the regional and local geology at JOAAP. This summary provides a background for understanding the complexity of the geologic variables at the site.

7.1.2 Regional Geology

The regional geologic setting of JOAAP is typical of the Central Lowlands Physiographic Province. This region is typified by subhorizontal Paleozoic sedimentary rocks, both carbonates and clastics, which are often uniform in character over extensive areas. These older formations are widely covered by sands, silts, and clays deposited during Pleistocene glaciation.

In the northeast corner of Illinois, three groups of aquifers are generally recognized. These include surficial aquifers within the widespread veneer of glacial sediment, a shallow bedrock aquifer, and a deep bedrock aquifer.

The Pleistocene glacial deposits include a heterogeneous assemblage of clays, silts, sands, and gravels. These sediments were deposited directly by the glacier (till), or by streams in or adjacent to the glacier (outwash). Outwash deposits, which usually include permeable sand and gravel beds, often serve as good aquifers.

The shallow bedrock aquifer is composed of dolomites of Silurian Age and lies beneath the glacial drift. The Silurian dolomite is between 50 and 100 feet thick. Beneath the Silurian dolomite is the Maquoketa Group. The Maquoketa Group is about 150 feet thick and is composed largely of shale with some dolomite beds. The Maquoketa Group is a regional confining unit, which separates the shallow and deep bedrock aquifer systems. The only two aquifers, which have been historically affected by contaminants at JOAAP, are the shallow unconsolidated deposits and the Silurian dolomite.

The deep bedrock system (beneath the Maquoketa Group) includes several major stratigraphic units that form the deep bedrock aquifer. Notable units are the Galena-Platteville Dolomite, the St. Peters Sandstone, and the Mt. Simon Formation. The deep bedrock aquifer provides most of the groundwater used in northern Illinois.

The structural geology of northeastern Illinois, like most of the midcontinental region, is not complex. The JOAAP site is situated on the Kankakee Arch, a broad structural high that separates the Michigan Basin to the northeast from the Illinois Basin to the south. The rock strata in the vicinity of JOAAP dip gently to the east at a rate of about 10 feet per mile (less than 1 degree), indicating that JOAAP is on the east flank of the arch.

The Sandwich Fault Zone passes through the eastern portion of JOAAP (Figure 7-28). This is a major regional fault zone that has been mapped for 85 miles in a northwesterly direction from Will County to Ogle County, Illinois. It is a normal fault with a displacement of about 150 feet in Will County. The south side of the fault is the downthrown side. The fault was probably formed in mid- to late Paleozoic times. It is not believed to be active today (personal communication, Dennis Kolata, Illinois Geological Survey, 1993). This fault occurs significantly north of the GOU and does not have an effect on groundwater flow or contaminant transport in the GRUs.

Details of local structural geology are not well known because outcrops are few. However, a previous investigation of the facility included a photogeologic study. This study concluded that there were two sets of bedrock fractures in the vicinity of JOAAP, a northwest-southeast set, and a northeast-southwest set. Many individual fractures could be traced for up to 2,000 feet (Figure 7-28). The frequency and orientation of these fractures may have a significant influence on the transport of contaminants within the dolomite bedrock.

7.1.3 Local Geology

At JOAAP, two glacial deposits have been identified: the Henry and the Wedron formations. The Henry Formation underlies most of the outwash plain in the central and western parts of the MFG Area. It includes sandy and gravelly silts and distinct beds of sand and gravel, and is 5 to 25 feet thick. The Wedron Formation is extensive in the upland area east of the main part of the MFG Area. This formation is a till composed of clayey silt with minor sand. The combined thickness of both Wedron and Henry formations is generally less than 25 feet in the western part of the MFG Area. In the eastern part of the MFG Area, the thickness increases to 60 to 70 feet. The overall thickness of the unconsolidated deposits is shown on Figures 7-1 through 7-8 for the LAP Area and Figures 7-9 through 7-27 for the MFG Area.

The Silurian dolomite is the underlying bedrock throughout the MFG Area. In logs of numerous borings, the dolomite is described as a fine-grained rock, commonly pyritic, and in some places, includes shaley beds. The dolomite is yellow or yellow-brown where it is weathered, and gray or greenish gray otherwise.

As a basis for understanding the site-specific lithologies, two geologic cross sections are presented for each individual site, one with a north-south orientation and the other with an east-west orientation. Each cross section was prepared from boring logs completed by various contractors from various time periods. Figures 7-1 through 7-8 present north-south (A-A') and east-west (B-B') cross-sections of LAP Sites L1, L2, L3 and L14. Figures 7-9 through 7-27 present north-south, east-west, and some other oriented cross-sections for each MFG site.

7.1.4 Hydrogeology

Hydrogeological characteristics at each site will influence the natural attenuation mechanisms. These characteristics include the number of aquifers, and aquitards in which contaminants are transported, the variability of hydraulic conductivity, depth to groundwater, groundwater velocity, hydraulic gradients, and fracture flow verses laminar flow.

Water levels measured during October 2003 well gauging activities were used to prepare water table maps and potentiometric surface maps for the GOU sites, except Site M10. At Site M3, monitoring wells are screened in the shallow bedrock aquifer, and therefore, no water table map was generated. The configuration of the water table on the recent water table maps is similar to that of the water table maps produced during the RI and indicate consistent gradients and flow directions. The potentiometric surface across the facility ranges from 522 to 546 feet mean sea level (MSL). The horizontal component of groundwater flow in the glacial drift and shallow bedrock aquifer systems is predominantly to the west toward the major surface water drainages. This westerly flow in the uppermost aquifer system is illustrated by the decline in the water table elevation from east to west.

The predominant flow from east to west is influenced locally by the surface topography and the larger streams in the area.

Historic water levels measured at each site were also plotted versus time. The plots were evaluated to determine unusual fluctuations in elevations that may have occurred which might affect groundwater flow at a particular site. These plots are presented in Appendix H.

Water level measurements collected during the October 2003 sampling event were used to calculate vertical gradients between the overburden and bedrock for well pairs located throughout JOAAP (Table 7-3). Based on these data, a downward component of flow between the overburden and bedrock is generally present east of the outwash plain. Exceptions are noted in well pairs located adjacent to Prairie Creek in the LAP Area, where gradients are upward, indicating that this creek is an area of shallow groundwater discharge. Another exception is well pair MW166 and MW320 at the TNT Ditch (Site M6) in the MFG Area, where the vertical gradient indicates upward flow and well MW320 has occasionally been observed to be under artesian conditions. In contrast, vertical gradients west of the outwash plain are generally considerably less than vertical gradients to the east. This suggests that groundwater tends to flow horizontally within both the overburden and bedrock in western portions of the site. It should be noted that west of the outwash plain, the overburden thins to less than 5 feet in some areas; and the water table in this area is often encountered at or near the overburden/bedrock contact.

Water level measurements collected during the October 2003 sampling events were also used to calculate horizontal gradients (Table 7-2). Horizontal gradients are more variable in the glacial overburden aquifer due to soil heterogeneity. Horizontal gradients were less variable in the shallow bedrock aquifer.

The hydraulic conductivity of the bedrock and overburden at JOAAP is calculated from various slug tests performed as part of previous studies and the RIs (OHM, 1997, Dames & Moore, 1997). Calculated overburden hydraulic conductivity values range from 1.5×10^{-6} to 1.8×10^{-2} centimeters per second (cm/sec). This range demonstrates the variability of glacial deposits, which range from clays and silt deposits to gravelly sands in the outwash plain. The average hydraulic conductivity of the overburden is calculated to be 1.7×10^{-3} cm/sec. In comparison, the hydraulic conductivity of the bedrock appears to be less variable, ranging from 2.0×10^{-4} to 1.6×10^{-3} cm/sec, with an average of 4.9×10^{-4} cm/sec. These differences in hydraulic conductivity increase the complexity of the sites. Using hydraulic conductivity data, horizontal gradients, and effective porosity, flow velocities were calculated for GOU sites (Table 7-1).

7.1.5 Surface Water Hydrology

Surface water drains either to the Des Plaines and Kankakee Rivers, whose confluence is adjacent to the western boundary of JOAAP. The LAP Area drains via several creeks and ditches to the Kankakee River, whereas the MFG Area drains via several creeks, ditches, and storm water conveyances to either the Des Plaines or Kankakee Rivers. The Grant Creek basin and the Prairie Creek basin cover approximately 70 percent of the installation (Diodato et. al., 1991). Studies of historical floods in the area by the U.S. Geological Survey (USGS) and 100-year flood maps indicate that portions of the LAP Area are subject to flooding. Depending on the hydraulic conditions, the streams and creeks may either be net influent (gaining) or effluent (losing) with respect to the groundwater flow.

7.1.6 Chemistry

Several chemistry criteria that were used to evaluate the monitored natural attenuation are the chemical characteristics of each aquifer in which a contaminant exists, the number of contaminants present at a site, and the complexity of the physical/chemical attenuation processes occurring within the aquifer.

The number of aquifers in which a contaminant exists is a criterion because the transport of a contaminant in multiple aquifers may require the calculations of multiple sets of coefficients that describe the transport of a constituent in each of the aquifers. There are two main aquifers affected at JOAAP, the unconsolidated aquifer and the underlying Silurian dolomite bedrock aquifer. However, most contaminant detections occur in the unconsolidated aquifer. The Maquoketa Shale, underlying the Silurian dolomite, is an aquitard that significantly retards the downward movement of contaminants.

The number of contaminants present at a site is also a significant criterion because different compounds are transported and decay at different rates. The Phase I and II RIs (OHM, 1997, and Dames & Moore, 1993, 1994) and the Proposed Plan (U.S. Army, 1997) identified three groups of COCs at JOAAP consisting of explosives, VOCs, and metals. Site-specific COCs are identified in Sections 7.2 through 7.4.

The physical/chemical attenuation properties of a contaminant within each aquifer will affect its transport and decay. The processes affecting contaminant attenuation are advection, dispersion, diffusion, sorption, and biodegradation. Each of these is described below:

7.1.6.1 Advection. Advective transport is defined as the movement of a solute with groundwater flow, such that the entire mass of the solute follows flow lines downgradient from the source. A non-reactive species introduced into the subsurface from a source area, following advective transport only, would arrive at a location downgradient as a sharp concentration front, or as a slug of contaminant. Solutes would migrate at a rate equal to the average linear velocity of the water (Freeze and Cherry, 1979). Therefore, differential average velocities through various aquifer matrices would result in some portion of the introduced contaminant moving through the matrix faster than other portions. Because advection will transport contaminants at different rates in each unit, the concentrations of contaminants measured in a composite sample collected from the aquifer at a location downgradient would be less than at the source (Fetter, 1993). This would provide a decrease in overall concentration of the contamination as the contaminant is transported away from the source.

7.1.6.2 Dispersion. The tendency of a solute to spread out and mix as it moves through the aquifer is termed dispersion. Dispersion is caused by both microscopic processes (mixing in pores, friction of water moving around individual grains) and macroscale processes (variations in hydraulic conductivity, aquifer stratigraphy, and tortuosity of flow paths). Dispersion will cause some of the contaminants to move faster than predicted by the average linear velocity and some to move slower. Mixing can occur both parallel to the groundwater flow direction (longitudinal dispersion) or perpendicular to the flow path (transverse dispersion). Longitudinal dispersion will result in a contaminant arriving at a location somewhat ahead of that predicted by the average linear velocity, but at lower concentrations. Transverse dispersion will result in the spreading of contaminants, both horizontally and vertically, as the solute moves through the aquifer. Although the total mass of the solute in the aquifer will remain the same, the solute mass occupies an increasingly larger volume of the aquifer during transport and the maximum concentration of the contaminant in the aquifer decreases with time. Mechanical dispersion can be expressed in terms of a dispersivity coefficient (length) multiplied by the average linear velocity (length/time) and therefore has units of L^2/time.

7.1.6.3 Diffusion. Diffusion refers to the movement of a solute from regions of high concentrations to areas with lower concentrations. Diffusion is independent of fluid flow and is mainly a function of concentration gradients. At very low groundwater flow velocities, diffusion can be a more important contributor than dispersion for spreading contaminant mass, whereas at higher velocities, dispersion becomes dominant. In low permeability materials, diffusion can cause contaminants to move considerable distances into the matrix. In situations where the aquifer is fractured, diffusion will occur as contaminant mass moves from the fracture fluid into a lower permeability porous matrix between fractures. This will result in the apparent loss of contaminant mass from the fracture flow regime. Likewise, if greater concentrations of contaminants are located in the aquifer matrix compared with local groundwater, diffusion will result in contaminant mass transfer back from the aquifer matrix to the groundwater system. Often this effect is observed at the latter stages of remediation as a tailing effect, when removal concentrations reach asymptotic levels.

7.1.6.4 Sorption. Solutes may be adsorbed or disrobed by soil and groundwater organic matter present in the aquifer. The amount of contaminant that is adsorbed is a function of soil grain size, mineral composition, organic content, solute composition, and solid concentration. Of the variety of soil components that can influence adsorption rates, organic carbon content is generally most significant. The adsorption capacity of an aquifer is typically expressed by the soil/water partitioning coefficient, or distribution coefficient (Kd). Kd is typically estimated as the organic carbon/water distribution coefficient (Koc) of a specific chemical multiplied by the soil organic carbon content (foc).

The effect of the aquifer matrix on the transport rate of organic chemicals in the saturated zone can be estimated by determining the retardation factor (Rf) for a chemical species. The Rf describes the effect of sorption in decreasing the rate of contaminant transport in the aquifer. For non-reactive species such as chloride, the transport rate would be equal to the groundwater flow velocity (Rf = 1).

The retardation rate is calculated as follows:

$$Rf = 1 + (Pb/n) \times Kd$$

Where:

Rf = Retardation Factor (unitless)
Pb = aquifer bulk density (g/m^3)
n = effective porosity (unitless)
Kd = distribution coefficient (ml/g)

And

$$Kd = Koc \times foc$$

where:

Koc = organic carbon partition coefficient (ml/g)
foc = organic carbon content (unitless)

7.1.6.5 Bioattenuation Mechanisms. Bioattenuation is the process by which contaminants are transformed from toxic to non-toxic byproducts through biologically mediated reactions that occur naturally in the groundwater system. Whereas physical attenuation processes reduce the contaminant concentrations and their overall toxicity in groundwater, bioattenuation includes biological and chemical processes that destroy contaminant mass. Loss of contaminant mass will reduce the volume of contaminants in the aquifer and result in overall plume shrinkage.

Proving that bioattenuation is occurring at a site is typically based on collection of site-specific information related to geologic and hydrogeologic characterization, the extent and distribution of contaminants, and the collection and analysis of specific chemical and physical attributes of the aquifer matrix and groundwater. Several investigators have developed lines of evidence which they believe can adequately demonstrate that bioattenuation is occurring at a site (Rifai et al., 1995, Wiedemeier, et al., 1995, 1996).

Rifai et al. (1995) states that three indicators of monitored natural attenuation should be developed from the site characterization data. The three indicators are: (1) compound disappearance demonstrating the decrease in contaminant concentrations as a function of time and distance from the source; (2) loss of electron donors; and (3) presence of degradation products and the accumulation of other indicator parameters of biodegradation.

Wiedemeier, et al. (1995, 1996) discuss three lines of evidence which can be used to support monitored natural attenuation: (1) documented loss of contaminant mass at the field scale; (2) biogeochemical evidence; and (3) microcosm studies. According to Wiedemeier, et al. (1996) microcosm studies are typically only needed when data are lacking on the first two lines of evidence.

This evidence includes:

1. Bioindicators of anaerobic conditions (dissolved oxygen, oxidation reduction potential, etc.).

2. Loss of electron donors/acceptors in areas of active biodegradation.

3. Loss of contaminant mass and presence of breakdown products.

4. Geochemical conditions.

5. Overlapping plumes of breakdown products.

7.1.6.6 Biotic Transformation. Microbial activity can result in biotic transformation of explosive compounds in groundwater. Promotion of microbial growth requires consistent groundwater flow, minimal fluctuations in water table level and groundwater flow direction, a neutral pH of between 6 and 8, adequate pH buffering to counter the acidification resulting from microbial activity, and moderate groundwater temperature. Also required are a carbon source and nutrients (nitrogen, phosphorus, and miscellaneous trace metals) for microbial growth, and electron donors/acceptors for energy production. Organic compounds, including organic contaminants, can be utilized both as a carbon source and as an electron donor. A minimum of 5 mg/L of total organic carbon must be present in groundwater in order to promote and sustain active biodegradation.

Microorganisms derive energy by oxidizing reduced compounds, a process which transfers electrons from an electron donor (reduced compound) to an electron acceptor (oxidized compound). Electron acceptors are utilized based upon their oxidation/reduction potential. The highest energy is derived from oxygen, followed in decreasing order by nitrate, manganese (IV), iron (III), sulfate, and carbon dioxide. Consequently, microbial processes are expected to evolve over time as electron acceptors are depleted. An aerobic environment is expected initially, but oxygen concentrations decrease as microbial activity depletes the high-energy oxygen. Once oxygen is depleted, nitrate becomes the preferred electron acceptor, resulting in a denitrificating environment. As nitrate concentrations decrease, manganese (IV), iron (III), sulfate, and carbon dioxide are progressively utilized and depleted. Correspondingly, increased concentrations of reduced manganese (II) and iron (II), hydrogen sulfide, and methane are expected.

The highest energy electron acceptor available to a microbial population dictates the mechanism for biotic transformation of explosive compounds in a contaminant plume.

Under aerobic conditions, explosive compounds function as electron donors and are oxidized. In the absence of oxygen, (i.e. anaerobic conditions), a reducing environment prevails, and explosive compounds function as electron acceptors.

Aerobic and anaerobic biodegradation of explosive compounds has been previously demonstrated. There has been a significant amount of information developed on the breakdown pathways for TNT in particular. The electrophilic nature of this compound has favored reductive reactions over oxidation. Aerobic degradation pathways typically yield partially reduced nitroso and hydroxylamino compounds that form recalcitrant azoxy compounds through oxidative coupling. Anaerobic reduction of TNT follows one of two sequential pathways from either 4-amino-2,6-dinitrotoluene (4a,2,6-DNT) or 2-amino-4,6-dinitrotoluene (2a,4,6-DNT) to 2,6-dinitrotoluene to 2-amino-6-nitrotoluene to 2-nitrotoluene to 2-aminotoluene to toluene. Ultimately, toluene is mineralized to CO_2 and H_2O. Some researchers report the end product for anaerobic degradation to be 2,4,6-triaminotoluene (TAT). TAT has been reported to be highly unstable and is also irreversibly bound to soil under anaerobic and subsequent aerobic conditions.

Mineralization of toluene can occur under both aerobic and anaerobic conditions. In an aerobic environment, toluene is oxidized resulting in ring fission and subsequent rapid degradation through a series of steps where aldehydes and acids are formed. These by-products are quickly mineralized. There are at least four pathways through which toluene can be mineralized under anaerobic conditions. The anaerobic degradation of toluene typically proceeds through a series of steps resulting in the formation of alcohols, aldehydes, and acids prior to mineralization. Evidence of toluene production and subsequent mineralization is often undetected at sites because the biologically mediated reactions occur rapidly without the accumulation of by-products (Cookson, 1995).

HMX has been demonstrated to degrade by abiotic, anaerobic, and aerobic mechanisms. Abiotic degradation by photolysis has led to the formation of nitrate, nitrite, and formaldehyde (Gorontzy, 1994). Anaerobic degradation of HMX has lead to the formation of mono-nitroso and di-nitroso derivatives and potentially can yield a small concentration of methanol. These breakdown products can be difficult if not impossible to analyze in field samples, especially in the low concentrations one would expect to find them at JOAAP. Aerobic degradation of HMX can be achieved with similar breakdown products resulting (Kaplan, 1993).

RDX has been demonstrated to degrade by abiotic, anaerobic, and aerobic mechanisms. Abiotic degradation by photolysis has led to the formation of a mono-nitroso derivative, nitrate, nitrite, ammonium, formaldehyde, and various amides, amines, and acids. Aerobic degradation of RDX has lead to the formation of mono-nitroso and di-nitroso derivatives. Anaerobic degradation of RDX can be achieved with similar breakdown products as well as tri-nitroso triazines, hydrazine, dimethylhydrazine, formaldehyde, and methanol (Gorontzy, 1994). These breakdown products can be difficult if not impossible to analyze in field samples, especially in the low concentrations one would expect to find them at JOAAP.

Tri-, di-, and nitrobenzene have been demonstrated to degrade by anaerobic mechanisms. The degradation pathway can involve the formation of a nitrosobenzene compound, a hydroxylaminobenzene, and 2-aminophenol. If the system becomes aerobic, the 2-aminophenol is transformed to 2-aminomuconic semialdehyde, which can be further degraded (Haigler, 1996).

Trends in electron donor and acceptor data are still vague at most explosives contaminated sites. Further investigation will be required at JOAAP to determine how useful these bioparameters will be for the LTM program.

7.1.6.7 Attenuation of Metals. Based on the predesign investigation results, there are no metals exceedances of RGs in the GOU sites. Therefore, no potential exists for metals concentrations greater than site RGs to migrate beyond the GMZ boundaries. The concentrations of metals that exist below RGs at GOU sites will continue to be attenuated through the process of dispersion.

7.2 GRU1 – EXPLOSIVES IN GROUNDWATER

GRU1 is entirely in the LAP Area and consists of separate plumes emanating from sources in Sites L1, L2, L3, and L14 (Figures 7-29, 7-32, 7-35, and 7-38, respectively). The Phase I and II RI reports concluded that explosives were the only contaminants found in these plumes that could pose a risk to human health or the environment. The RI Reports also concluded that GRU1 plumes occurred within the glacial drift aquifer at these sites, and the plumes extended into the shallow bedrock aquifer at Sites L1, L2, and L3, but not at Site L14.

The following discussions are a summary of the groundwater LTM water quality results, along with a summary of site characteristics. The purpose of these summaries is to evaluate whether the monitored natural attenuation remedy is performing adequately at each site.

7.2.1 Site L1

Site L1 (Figure 3-1) is approximately 80 acres and was used for demilitarization and reclamation of various munitions including de-fusing of munitions, removal of the explosives, and recycling of the casings. This site contains a 10-acre ridge and furrow system that was used to evaporate pink water discharge from an on-site sump. The monitoring wells within Site L1 consist of eight overburden wells, one combined well, seven deep bedrock wells, and one surface water monitoring location (Figures 3-2 and 7-30).

7.2.1.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater from Site L1 was sampled for explosives and monitored natural attenuation indicator parameters during October 2003 (Table 7-4 and 7-5, respectively). Historic data tables are included in Appendix C. The extent of the explosive plume in groundwater and individual explosive compound detections during October 2003 at Site L1 have been included in Figure 7-29. The RG for TNB (5.1 ug/L) has routinely been exceeded in well MW131 (Figure 6-1). Concentrations of TNB at MW131 have declined from the highest detection of 4,670 ug/L during July 1998 to 1,100 ug/L during October 2003. TNB was not detected at MW131 during October 2002 or May 2003. The Mann-Kendall statistical test indicated a non-stable trend (CV>1) for TNB at MW131 (Appendix F). Monitoring well WES1, a shallow bedrock well just downgradient of the soil source area, has routinely had TNB RG exceedances. Downgradient overburden and bedrock wells MW172 and MW173 have not had exceedances of TNB since 1991 (Figure 6-2 and 6-3, respectively).

The RG for TNT (9.5 ug/L) has routinely been exceeded at well MW131 (Figure 6-1). Concentrations of TNT have declined from the highest detection of 5,200 ug/L during July 1999 to 840 ug/L during October 2003. The Mann-Kendall statistical test indicated a stable trend (CV<1) for TNT at MW131 (Appendix F). Monitoring well WES1, a shallow bedrock well just downgradient of the soil source area, has routinely had TNT RG exceedances. Downgradient overburden well MW172 has not had an RG exceedance for TNT since 1986 (Figure 6-2), while downgradient bedrock well MW173 has routinely exceeded the RG for TNT (Figure 6-3).

In Figures 6-1 through 6-3, a best-fit curve is extrapolated through one of the explosives compounds presented on the graph. To provide an estimate of the time required for the selected explosives compound to naturally degrade to less than site RGs, the best-fit curve on Figure 6-1 was used to project a potential contaminant reduction rate. Table 6-1 summarizes the results of this analysis. Given the equation to the best-fit curve for TNT at MW172 and MW173, the estimated time at which this compound will naturally degrade to less than site RGs is –8 and 14 years or in the years 1996 and 2018, respectively (Table 6-1). However, based on actual sampling results for MW172, TNT levels dropped below the RG during 1986 demonstrating the conservative nature of the estimate. At monitoring well MW131 the estimated time at which TNT will be degraded to less than site RGs is 402 years (or the year 2406; Table 6-1). The same analysis for TNB at MW131 estimated that the concentration should drop below the RG in 87 years or by the year 2091.

Monitoring well MW173 is designated as an in-plume well at Site L1. Downgradient early-warning bedrock well WES3 has not had TNT RG exceedances. The RG for RDX (2.6 ug/L) has historically been exceeded at monitoring well MW172 and has routinely been exceeded at MW173 (Appendix C). There have been no RDX exceedances at early warning bedrock well WES3.

Bioparameters – Analytical results from this site exhibit declining concentrations of TNT, HMX, and RDX. Downgradient concentrations of TNT were significantly lower than upgradient concentrations. The TNT biodegradation product 2a,4,6-DNT was detected in significant concentrations in wells where TNT was also present. Adequate concentrations of organic carbon were found during the 1998 baseline sampling (an average of >10 mg/L TOC for the site) which could sustain biodegradation mechanisms. TOC levels have dropped in site wells to marginal levels, with the average TOC being 3.4 mg/L during October 2003. While the groundwater appears to be mostly aerobic, there also appears to be pockets of sulfidogenic activity at the site. Samples collected from monitoring well MW131 have exhibited decreasing concentrations of sulfate since initially being sampled during June 1981. Sulfidogenic activity could be a mechanism for natural attenuation of explosives at Site L1. Compared to other sites at JOAAP, this site is exhibiting the strongest baseline evidence of explosives biodegradation given the contaminant reductions, significant presence of breakdown products, and other indicator parameters.

Geology – The unconsolidated deposits at the site generally consist of silt, clay, silty sand, and sandy silts. Occasional clayey sands and gravelly sand seams were reported in three of the boring logs. The dolomite bedrock surface ranges from 6.5 to 21 feet below ground surface (Figures 7-1 and 7-2). The fracture trace map indicates two small, east-west trending fractures in the east portion of the site and a small northeast-southwest trending fracture in the center of the site (Figure 7-28).

Hydrogeology – Groundwater in the overburden flows to the southwest beneath Site L1, and likely discharges to Prairie Creek (Figure 7-30). The water table depth is approximately 5.1 to 20.4 feet below ground surface at Site L1 (Figures 7-1 and 7-2). Flow in the bedrock is also toward the southwest (Figure 7-31). Water level elevations versus time plots for Site L1 monitoring wells are included in Appendix H. Other than seasonal variation, no drastic changes in groundwater elevation have occurred at site monitoring wells.

The vertical gradient measured at well nest MW172/MW173 is slightly upward (Table 7-7). Vertical gradients have remained constant at site well nests with the exception of well nest MW177/MW171. The gradient is normally downward, but upward gradients were observed during October 2000 and 2001 (Table 7-3). The average horizontal gradient at Site L1 during October 2003 was 0.0075 ft/ft (Table 7-8). Horizontal gradients have ranged from 0.0069 ft/ft to 0.0125 ft/ft (Table 7-2) during LTM activities. Assuming an effective porosity of 0.30, the average linear velocity during October 2003 was 0.0007 ft/day (Table 7-9). Linear velocities have ranged from 0.0006 ft/day to 0.0011 ft/day at Site L1 (Table 7-1).

Model Results - Monitoring well MW131 was selected as the source location for the Site L1 model. The TNB detection of 4,670 ug/L at MW131 during July 1998 was selected as the source concentration. A first order decay rate constant of 1.1E-01 yr^{-1} was used for TNB. The first order decay rate constant is based on LTM analytical data (Appendix E). Model results indicate the maximum predicted transport distance of RG exceedances

(<300 ft) will not reach Prairie Creek (1,000 ft) and should therefore not reach the southern edge of the GMZ (1,400-ft). Model results are summarized in Table 6-2 and included in Appendix G.

Summary - There is no evidence to suggest that there have been RG exceedances for explosive compounds outside the GMZ throughout all sampling conducted at Site L1. While the Mann-Kendall analysis indicated a non-stable trend for TNB at MW131, there have been no RG exceedances for TNB in downgradient wells (MW172, MW173, and MW174) during LTM monitoring. BIOSCREEN model results indicate a maximum predicted contaminant transport distance of RG exceedances of <300 ft. In addition, there have been no detections for explosives at surface water location SW550. The Mann-Kendall test indicated TNT concentrations are stable at monitoring well MW131. RG exceedances for TNT have routinely occurred at overburden well MW173, but no detections of TNT have occurred at surface water location SW550. Prairie Creek is the likely discharge point for overburden groundwater. Upward vertical gradients were observed at well nests MW172/MW173 and MW401/MW610 during October 2003. Well nests MW172/MW173 and MW401/MW610 are located on the north and south sides of Prairie Creek, respectively.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. The remedy is expected to be protective of human health and the environment when the soil source RA is completed at Site L1. Soil RA activities are scheduled to occur during fiscal year 2005. Table 7-10 lists the institutional controls implemented at Site L1. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.2.1.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time Of The Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.2.1.3 Question C: Has any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.2.2 Site L2

Site L2 is located in the west-central portion of the LAP Area, adjacent to Prairie Creek and Kemery Lake (Figure 3-1). The operational area covers approximately 5 acres. Elevated burning pads at the site were used to burn explosives, explosive waste, and spent carbon from the melt-load processes. This activity resulted in the contamination of soil and groundwater. Several separate plumes were identified at this site during the RI. The monitoring wells within this site consist of four overburden wells, six combined wells, and one bedrock well (Figures 3-2 and 7-33).

7.2.2.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater from Site L2 was sampled for explosives and monitored natural attenuation indicator parameters during October 2003 (Tables 7-4 and 7-5, respectively). Historic groundwater tables are included in Appendix C. The extent of the explosive plume in groundwater and individual explosive compound detections during October 2003 at Site L2 has been included in Figure 7-32. The RG for RDX (2.6 ug/L) has routinely been exceeded at well MW404 (Figure 6-4). Concentrations of RDX have declined from the highest detection of 640 ug/L during September 1991 to 320 ug/L during October 2003. RDX detections at MW404 were as low as 35 ug/L during May 2002. The Mann-Kendall statistical test indicated a decreasing trend for RDX at MW404 with an 80% confidence level. The data input for the Mann-Kendall test was corrected for seasonal variation (Appendix F).

In Figure 6-4, a best-fit curve is extrapolated through RDX on the graph. In order to get an estimate of the time required for RDX to naturally degrade to less than site RGs, the equation to the best-fit curve on Figure 6-4 is used to project a potential contaminant reduction rate. Table 6-1 summarizes the results of this analysis. Given the equation to the best-fit curve for explosives compound RDX at MW404, the estimated time at which this compound will naturally degrade to less than site RGs is 37 years (or in the year 2041; Table 6-1).

No RG exceedances for RDX have occurred at surface water location SW555 or at well nest MW620/MW621. RDX has only been detected once at SW555 during LTM activities. The detection at 0.56 ug/L of RDX occurred during May 2001. The surface water RG for RDX is 500 ug/L.

Bioparameters – RDX detections found at Site L2 exhibit a declining trend (Figure 6-4). The TNT degradation product, 2a-4,6-DNT, was detected once at MW405 during July 1998. Some photolytic degradation of TNT has also taken place as indicated by the detection of 1,3,5-TNB at SW555 during May 2002. A marginal concentration (average of 4 mg/L) of organic carbon was found which could sustain biodegradation mechanisms. Nitrate levels have declined significantly at MW404 indicating that denitrification may be occurring at Site L2. Dissolved oxygen levels at MW404 have remained below 1.0 mg/L and reduction-oxidation potential (Red-Ox) has steadily declined since July 1998, indicating an anaerobic condition. More nitrate depletion exists at this site than at Site L1, further supporting the anaerobic condition. As such, this site is exhibiting adequate evidence of biodegradation.

Geology – The unconsolidated deposits at the site generally consist of silt, clay, clayey sands, and clayey gravels. The dolomite bedrock surface ranges from 12 to 25 feet below ground surface (Figures 7-3 and 7-4). No significant bedrock fractures are evident on the fracture trace map (Figure 7-28).

Hydrogeology – Groundwater flows to the northwest beneath Site L2, and likely discharges to Prairie Creek (Figure 7-33). Flow in the bedrock is to the north (Figure 7-34). Due to the limited number and location of water table observation wells, several of the combined wells (water table and shallow bedrock) were used to construct Figure 7-33. There appears to be a hydraulic connection between the two aquifers at this site. The water table depth is approximately 2.5 to 10.2 feet below ground surface at Site L2 (Figure 7-3 and 7-4). Water level elevations versus time plots for Site L2 monitoring wells are included in Appendix H. Other than seasonal variation, no drastic changes in groundwater elevation have occurred at site monitoring wells during the LTM.

The vertical gradient at well nest MW620/MW621 was slightly upward during October 2003 (Table 7-7). The vertical gradient at well nest MW620/MW621 has fluctuated, switching directions nearly each LTM event (Table 7-3). The average horizontal gradient at Site L2 during October 2003 was 0.0164 ft/ft (Table 7-8). Horizontal gradients have ranged from 0.0147 ft/ft to 0.0208 ft/ft (Table 7-2). Assuming an effective porosity of 0.30, the average linear velocity at Site L2 during October 2003 was 0.2479 ft/day (Table 7-9). Flow velocities have ranged from 0.2222 ft/day to 0.3140 ft/day (Table 7-1) at Site L2.

Model Results - Monitoring well MW404 was selected as the source location for the Site L2 model. The RDX detection of 357 ug/L during July 1998 at MW404 was selected as the source concentration. A first order decay rate constant of 1.0E-01 yr^{-1} was used for RDX. The first order decay rate constant is based on LTM analytical data (Appendix E). Model results indicate the maximum predicted transport distance of RG exceedances (<480 ft) will likely discharge into Prairie Creek (150 ft) prior to reaching the GMZ at the opposite bank of the creek. Model results have been summarized in Table 6-2 and included in Appendix G.

Summary - Reported concentrations of explosives from LTM activities indicate exceedances of the RG for RDX only at monitoring well MW404. The Mann-Kendall statistical test indicated a decreasing trend for RDX at MW404 with an 80% confidence level. BIOSCREEN modeling results indicate a maximum predicted transport distance of <750 ft. Groundwater likely discharges to Prairie Creek located approximately 150 ft from well MW404. No RG exceedances for RDX have occurred at surface water location SW555, the point of compliance for the GMZ. The vertical gradient at well nest

MW620/MW621 was upward during October 2003 (Table 7-7). Historically (July 1998) an exceedance of the RG for RDX occurred at well MW405. Because these wells are screened in both unconsolidated soils and bedrock, it is likely that RG exceedances occur in both the unconsolidated deposits and shallow bedrock.

Metals concentrations in soils near the popping furnaces may also have resulted in groundwater contamination near MW501. However, little historical data exist to confirm or refute metals concentrations in groundwater near the popping furnaces or downgradient of the North Oil Pit. Excavation or disturbance of the soil or vegetative cover could accelerate infiltration in these areas, thus increasing the potential for mobilizing metals to the groundwater during SOU RA activities at Site L2. Metals should be analyzed for one year after SOU RA activities then reevaluated based on analytical results.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. The remedy is expected to be protective of human health and the environment when the soil source RA is completed at Site L2. Soil RA activities are scheduled to occur during fiscal year 2006. Table 7-10 lists the institutional controls implemented at Site L2. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.2.2.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.2.2.3 Question C: Has any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.2.3 Site L3

Site L3 was used for the open burning of combustible refuse and munitions crates. U- and L-shaped berms were constructed along the east side of Prairie Creek, and a similar sized bermed area was located between the fire training area and demolition pits for burning operations. The location of Site L3 is shown on Figure 3-1. The monitoring wells within this site consist of five overburden wells, two combined wells, and four bedrock wells (Figures 3-2 and 7-36).

7.2.3.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater from Site L3 was sampled for explosives and natural attenuation indicator parameters during October 2003 (Tables 7-4 and 7-5, respectively). Historic data tables are included in Appendix C. The extent of the explosive plume in groundwater and individual explosive compound detections during October 2003 have been included in Figure 7-35. The RG for RDX (2.6 ug/L) has routinely been exceeded in well MW412 (Figure 6-5). Concentrations of RDX at MW412 have declined from the highest detections of 200 ug/L and 210 ug/L during July 1999 and May 2001, respectively, to 58 ug/L during October 2003. The Mann-Kendall statistical test for MW412 at Site L3 indicated a decreasing trend for RDX and HMX at an 80% confidence level (Appendix F).

On Figure 6-5, a best-fit curve is extrapolated through RDX on the graph. In order to get an estimate of the time required for RDX to naturally degrade to less than site RGs, the equation to the best-fit curve on Figure 6-5 is used to project a potential contaminant reduction rate. Table 6-1 summarizes the results of this analysis. Given the equation to the best-fit curve for explosives compound RDX at MW412, the estimated time at which this compound will naturally degrade to less than site RGs is 27 years (or in the year 2031; Table 6-1).

Since monitoring well MW412 is a shallow bedrock well, it is likely that RG exceedances occur in both the unconsolidated deposits and bedrock. Downgradient bedrock well MW633 has had periodic exceedances of the RG for RDX including October 2003 (9.8 ug/L). Surface water locations downstream of MW412 (SW557 and SW777) have had detections for RDX but none greater than the surface water RG of 500 ug/L. All levels of RDX at surface water locations have been below groundwater RG levels (2.6 ug/L) except at SW777 during May 2002.

Bioparameters – Site L3 has shown declining concentrations of the explosive compounds HMX and RDX. Little organic carbon was found (average of 1.7 mg/L at Site L3), so it is questionable whether biodegradation mechanisms could be sustained. Dissolved oxygen levels demonstrates seasonal variation with concentrations averaging about 3 mg/L during spring when groundwater recharge occurs and an average of approximately 1.7 mg/L during fall. This trend indicates that dissolved oxygen is being used as an electron acceptor during aerobic respiration at Site L3. More nitrate depletion exists at this site than at Sites L1 and L2. Nitrate nitrogen is likely being depleted when dissolved oxygen levels drop below 1.0 mg/L. Red-ox potential has exhibited a declining trend since LTM was initiated. Red-ox potential typically drops in groundwater in an area with biological activity. Site L3 is exhibiting adequate baseline evidence of natural attenuation, but the low organic carbon concentration may be a limiting factor to biodegradation.

Geology – The unconsolidated deposits at the site generally consist of silty clay and silt. A thin, 1-foot sand seam, at a depth of 10 to 13 feet, may be continuous across the site. Sand and sandy clays increase in thickness near Prairie Creek. The dolomite bedrock surface ranges from 3 to 28 feet below ground surface (Figures 7-5 and 7-6). No significant bedrock fractures are evident on the fracture trace map near Site L3 (Figure 7-28).

Hydrogeology – Groundwater flows to the west/southwest beneath Site L3, and likely discharges to Prairie Creek (Figure 7-36). The water table depth is approximately 4.9 to 21.6 feet below ground surface (Figures 7-5 and 7-6). Potentiometric surface contours indicate flow in the bedrock is toward the west (Figure 7-37). Water level elevations versus time plots for Site L3 monitoring wells are included in Appendix H. Monitoring well MW137 shows more variability in groundwater elevation than other site wells but follows the same trends in elevation change. Other than seasonal variation, no drastic changes in groundwater elevation have occurred at site monitoring wells.

The vertical gradient at monitoring well nest MW630/MW631 is slightly upward (Table 7-7). The vertical gradient at well nest MW630/MW631 has remained upward ranging from 0.0309 ft/ft to 0.0744 ft/ft (Table 7-3). The average horizontal gradient at Site L3 during October 2003 was 0.0237 ft/ft (Table 7-8). Horizontal gradients have ranged from 0.0215 ft/ft to 0.0243 ft/ft (Table 7-2). The average linear velocity at Site L3 was determined to be 0.36 ft/day during October 2003 (Table 7-9). The flow velocity at Site L3 was calculated using hydraulic conductivity values from nearby Site L2. No values are available for Site L3. Flow velocities have ranged from 0.3250 ft/ft to 0.3673 ft/ft (Table 7-1) during the LTM.

Model Results - Monitoring well MW412 at Site L3 was selected as the source location for the model. The recent RDX detection of 200 ug/L during July 1999 at MW412 was selected as the source concentration. A first order decay rate constant of 1.46E-01 yr^{-1} was used for RDX. The first order decay rate constant is based on LTM analytical data (Appendix E). Model results indicate that maximum predicted transport distance of RG exceedances (<750 ft) will remain within the GMZ and should not reach the limits of Prairie Creek (1,400 feet). Model results have been summarized in Table 6-2 and included in Appendix G.

Summary - Groundwater RDX concentrations have exceeded the RG at wells MW412 and MW633 during LTM. Both wells are screened across the overburden and shallow bedrock. The Mann-Kendall statistical test for monitoring well MW412 at Site L3 indicated a decreasing trend for RDX and HMX at an 80% confidence level (Appendix F). BIOSCREEN modeling results indicate that the maximum predicted transport distance of RG exceedances is <450 ft. The vertical gradient at well nest MW630/MW631 was upward during October 2003 (Table 7-7). No exceedances of the surface water RG (500 ug/L) have been exceeded at surface water location SW777, the point of compliance for the GMZ. Detection of RDX at concentrations less than the RG for RDX were also reported at well MW410. The remaining wells in Site L3 have consistently yielded no reported concentrations of explosive compounds.

Metals concentrations in soils near the burning cages and demolition areas, as well as the amount of metals debris buried at the site, suggest that further evaluation of metals concentrations in groundwater be conducted. Little historic data exist to confirm or refute groundwater metals concentrations at Site L3. Also, excavation or disturbance of the soil or vegetative cover could accelerate infiltration in these areas, thus increasing the potential for mobilizing metals to the groundwater during SOU RA activities at Site L3. Metals should be analyzed at wells MW411, MW410, MW630, and MW631 for one year after SOU RA activities then reevaluated based on analytical results.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. The remedy is expected to be protective of human health and the environment when the soil source RA is completed at Site L3. Soil RA activities are scheduled to occur during fiscal year 2006. Table 7-10 lists the institutional controls implemented at Site L3. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.2.3.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.2.3.3 Question C: Has any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.2.4 Site L14

Site L14 is a 33-acre site located in the southwestern corner of the LAP Area, near Sites L15 through L19 (Figure 3-1). Site L14 was used for a variety of activities associated with munitions production and storage. Monitoring wells within this site consist of eight overburden wells, one combined well, and two bedrock wells (Figures 3-2 and 7-39).

7.2.4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater at Site L14 was sampled for explosives and natural attenuation indicator parameters during October 2003 (Tables 7-4 and 7-5, respectively). Historic groundwater tables are included in Appendix C. The extent of the explosive plume in groundwater and individual explosive compound detections during October 2003 at Site L14 has been included in Figure 7-38. The RG for RDX (2.6 ug/L) has routinely been exceeded in overburden wells MW508, MW511, and MW512 (Figures 6-6, 6-7, and 6-8, respectively). Mann-Kendall statistical test results indicated a stable trend (CV<1) for RDX at MW508. The data input for the Mann-Kendall test was corrected for seasonal variation (Appendix F).

In Figure 6-6, a best-fit curve is extrapolated through the RDX concentration presented on the graph. In order to get an estimate of the time required for the selected explosives compound to naturally degrade to less than site RGs, the equation to the best-fit curve on Figure 6-6 is used to project potential contaminant reduction rates; Table 6-1 summarizes the results of this analysis. Given the equation to the best-fit curve for explosives compound RDX at MW508, the estimated time at which this compound will naturally degrade to less than site RGs is 9 years (or in the year 2013; Table 6-1). Analyses on data from monitoring wells MW511 and MW512 indicated similar results. The estimated time at which RDX will naturally degrade to less than site RGs is 24 years for MW511 (or in the year 2028) and 20 years for MW512 (or in the year 2024).

RDX has periodically been detected at downgradient overburden well H7, but no RG exceedances have occurred during LTM activities. No detections of RDX have occurred at downgradient overburden wells MW601 and MW603 during LTM activities. In addition, no detections for RDX have occurred in downgradient bedrock wells MW602 and MW604 during LTM activities.

The RG for TNT (9.5 ug/L) was exceeded in wells MW508 (12.6 ug/L) and MW512 (12.8 ug/L) during baseline sampling in July 1998 (Appendix C). TNT was previously detected at Site L14 in the RI sampling round (Appendix C). No detections of TNT at monitoring wells MW508 and MW512 have occurred during LTM sampling at Site L14.

Bioparameters – TNT anaerobic degradation daughter products 2a,4,6-DNT and 4a,2,6-DNT have routinely been detected at overburden well MW512 since November 1999. Site L14 has exhibited declining concentrations of HMX. Little organic carbon was found (average of 1.6 mg/L at Site L14), so it is questionable whether biodegradation mechanisms could be sustained. Dissolved oxygen levels follow the same seasonal trend as observed at Site L3. Denitrification also appears to be occurring at site L14 based on reduction rates of nitrate nitrogen. Similar to Site L3, nitrate is likely being utilized as an electron acceptor during low levels of dissolved oxygen in the overburden aquifer. There also appear to be pockets of sulfidogenic activity at Site L14 that could be a mechanism in natural attenuation. Sulfate levels exhibit declining trends at monitoring wells MW508 and

MW600. This site exhibits adequate evidence of natural attenuation, but the low organic carbon concentration may be a limiting factor to biodegradation.

Geology – The unconsolidated deposits at Site L14 generally consist of silty clay, sandy silts, and silt. A sand seam was reported at well MW511, and 1-foot gravel seams overlying the bedrock were reported at well MW511 and MW512. The dolomite bedrock surface ranges from 12 to 22 feet below ground surface (Figures 7-7 and 7-8). An extensive northwest-southeast trending bedrock fracture is present through the center of the site (Figure 7-28).

Hydrogeology – Groundwater flows to the southwest beneath Site L14 (Figure 7-39). The water table depth ranges from 6.6 to 10.8 feet below ground surface (Figures 7-8 and 7-9). Flow in the bedrock aquifer is toward the west/southwest (Figure 7-40). Water level elevations versus time plots for Site L14 monitoring wells are included in Appendix H. Other than seasonal variation, no drastic changes in groundwater elevation have occurred at site monitoring wells during LTM.

Vertical gradients have remained downward in the central portion of the site and upward in the western portion (downgradient) of Site L14 (Table 7-3). Vertical gradients observed at the site during October 2003 have been included in Table 7-7. The average horizontal gradient at Site L14 was 0.0077 ft/ft (Table 7-8) during October 2003. Horizontal gradients have ranged from 0.0075 ft/ft to 0.0084 ft/ft (Table 7-2). The average linear velocity during October 2003 at Site L14 was 0.1164 ft/day (Table 7-7). The flow velocity at Site L14 was calculated using hydraulic conductivity values from nearby Site L2. No values are available for Site L14. Flow velocities during LTM activities at Site L14 have ranged from 0.1132 ft/day to 0.1270 ft/day (Table 7-1).

Model Results - Monitoring well MW508 was selected as the source location for the Site L14 model. The RDX concentration of 462 ug/L from July 1998 was selected as the source concentration. A first order decay rate constant of 2.92E-01 yr^{-1} was used for RDX. The first order decay rate constant is based on LTM analytical data (Appendix E). Model results indicate that maximum predicted transport distance of RG exceedances (<600 ft) will remain within the GMZ (1,000 feet). Model results have been summarized in Table 6-2 and included in Appendix G.

Summary - Groundwater RDX concentrations have exceeded the RG (2.6 ug/L) in the three in-plume wells (MW508, MW511, and MW512) during LTM. All in-plume wells are screened in the overburden groundwater. Mann-Kendall statistical test results indicated a stable trend (CV<1) for RDX at MW508. BIOSCREEN model results indicate a maximum predicted transport distance of <600 ft, well within the GMZ boundary. Historically, TNT exceeded the RG (9.5 ug/L) at two of the three in-plume wells (MW508 and MW512). Subsequently, TNT has not been detected during LTM activities although biodegradation products have been detected. There are no bedrock wells near the plume at Site L14. There have been no RG exceedances for explosive compounds in downgradient bedrock wells MW602 and MW604.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. The remedy is expected to be protective of human health and the environment when the soil source RA is completed at Site L14. Soil RA activities are scheduled to occur during fiscal year 2005. Table 7-10 lists the institutional controls implemented at Site L14. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.2.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.2.4.3 Question C: Has any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.3 GRU2 - EXPLOSIVES AND OTHER CONTAMINANTS IN GROUNDWATER

GRU2 is entirely in the MFG Area and consists of separate plumes emanating from sources at Sites M1 (Figure 7-41), M5, M6, M7, M8, and M13 (Figure 7-45). The following discussions are a summary of the LTM groundwater quality results along with a summary of site characteristics. The purpose of these summaries is to evaluate whether the monitored natural attenuation remedy is performing adequately at each site.

7.3.1 Site M1

Site M1 – The Southern Ash Pile, is a 68-acre tract in the southern portion of the MFG Area formerly used for the disposal of ash from red water incineration (Figure 3-1). The monitoring wells within this site consist of nine overburden wells, four combined wells, and five bedrock wells. The monitoring well locations are shown on Figures 3-2 and 7-42.

7.3.1.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater at Site M1 was sampled for natural attenuation indicator parameters (Table 7-5) during October 2003. Historic data tables are included in Appendix C. The extent of sulfate RG exceedances in groundwater and sulfate detections by well during October 2003 at Site M1 have been included in Figure 7-41. Although previously detected at low levels, there were no explosives, antimony, or cadmium detections in the baseline results. Therefore, sulfate has been the only analyte sampled for during LTM activities. Sulfate concentrations have routinely exceeded the RG (400 mg/L) in wells MW231, MW106, and MW107 (Figure 6-9). In addition, periodic to routine sulfate exceedances have occurred at monitoring wells MW351, MW640, MW641, and MW642 (Figure 6-10). The continuing exceedance of the RG for sulfate at wells MW641 and MW642 prompted the USACE to submit an ESD (USACE, 13-February-03) which requested a modification to the remedy for groundwater contamination at Site M1. The proposed remedy was to expand the west and north boundaries of the GMZ.

The overall trend of sulfate concentrations at Site M1 wells is increasing, with the exception of the stabilizing concentration observed at MW107 and a slightly declining trend at well MW641. The increasing trend in sulfate concentrations at Site M1 is likely due to limited source control measures performed at the ash pile. Expanding the GMZ at Site M1 eliminated, to date, exceedances of site RGs outside the site boundary. Continued monitoring of early warning wells along with sulfate trend analysis will help determine if the remedy meets the ROD objective for the M1 Site or if further changes will be necessary.

The surface water RG for sulfate (500 mg/L) has been exceeded at surface water locations SW702, SW703, and SW708. All of these locations are within the new GMZ boundary. Surface water within the GMZ must meet surface water RGs at the downstream boundary of the GMZ, the point of RG compliance. No RG exceedances of surface water criteria have occurred at locations within Prairie Creek (SW705, SW706, and SW707).

Bioparameters – Sulfate is continuing to leach from the ash landfill at concentrations similar to historical concentrations. Sulfate may have been a key electron acceptor in the degradation of explosives at this site and is clearly a site contaminant from the red water ash.

Geology – The unconsolidated deposits at the site generally consist of silt, clay, and silty sand. No sand or gravel seams were reported in any of the six on-site boring logs. The dolomite bedrock surface ranges from 16 to 27 feet below ground surface (Figures 7-9 through 7-11). Fracture trace maps indicate two major fractures that intersect in the north-central portion of Site M1 and trend northwest-southeast and northeast-southwest (Figure 7-28).

Hydrogeology – Groundwater flow beneath Site M1 is generally to the northwest toward Prairie Creek and an adjacent wetland area (Figure 7-42). These surface water features are the likely discharge points of local groundwater flow. The average water table depth was approximately 1.2 to 5.9 feet below ground surface at Site M1 during October 2003 (Figures 7-9 through 7-11). Flow in the bedrock aquifer is toward the northwest (Figure 7-43). Water level elevations versus time plots for Site M1 monitoring wells are included in Appendix H. Water table wells closer to Prairie Creek indicate more change than those near the interior of the site. This is to be expected with the groundwater/surface water interface along Prairie Creek. Other than seasonal variation, no drastic changes in groundwater elevation have been observed at site monitoring wells.

The vertical gradient at well nest MW641/MW642 has remained slightly downward and has switched direction at well nest MW351/MW640 during LTM activities (Table 7-3). The average horizontal gradient at Site M1 during October 2003 was 0.0121 ft/ft (Table 7-8). Horizontal gradients have ranged from 0.0083 ft/ft to 0.0175 ft/ft at Site M1 during the first five years of LTM at the site (Table 7-2). Assuming an effective porosity of 0.30, the average linear velocity at Site M1 during October 2003 was 0.0109 ft/day (Table 7-1). Flow velocities have ranged from 0.0052 ft/ft to 0.0109 ft/ft between 1999 and 2003 (Table 7-1).

Based on the results of the groundwater quality data it appears that sulfate is being transported in the bedrock as well as the unconsolidated deposits.

Model Results - Site M1 was not modeled because there are likely many attenuation mechanisms occurring within the bedrock aquifer that affect the transport of sulfate. These mechanisms could not be accounted for using BIOSCREEN and other available models. Evidence of these attenuation mechanisms is provided by the significant differences in sulfate concentrations between the monitoring wells immediately downgradient of the landfill and the distal downgradient wells.

Summary - Sulfate concentrations exceed the RG (400 mg/L) at nine well locations at Site M1. Although historically detected at relatively low concentrations, there were no explosives, antimony, or cadmium detections during Predesign groundwater monitoring conducted during 1998. Subsequently, metals and explosives analyses were dropped when the LTM Program was developed for Site M1. Reassignment of monitoring wells took place when the ESD (USACE, 13-February-03), was submitted which modified the remedy by expanding the GMZ at Site M1. It is expected that sulfate will continue to leach from the ash landfill until the source can be removed (i.e., the ash is excavated and disposed of at the Will County landfill).

The technical assessment indicates that the modified remedy is functioning as intended by the decision documents. The remedy is expected to be protective of human health and the environment when the red water ash removal is completed at Site M1. RA activities are scheduled to occur during fiscal year 2008. Table 7-10 lists

the institutional controls implemented at Site M1. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.3.1.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.3.1.3 Question C: Has any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.3.2 Site M5

Site M5, Tetryl Production Area, is a 244-acre tract in the central portion of the MFG Area (Figure 3-1). This site was formerly used for the production of tetryl. There were multiple production lines, each with a series of buildings for the various stages of tetryl manufacturing. The monitoring wells within this site consist of one overburden wells, four combined wells, and one shallow bedrock well. In addition, one surface water sample location is sampled at the confluence of Tetryl Ditch and Grant Creek (SWTET). The monitoring locations are shown on Figures 3-2 and 7-46.

7.3.2.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater at Site M5 was sampled for explosives and natural attenuation indicator parameters during October 2003 (Table 7-4 and 7-5). Detections of explosives at each monitoring well sampled at Site M5 during October 2003 have been included in Figure 7-44. The extent of explosives in groundwater at Site M5 have been depicted in Figure 7-45. Although tetryl was previously detected at low levels in well MW207 (less than the RG), there were no explosives detected in the baseline sampling results (Appendix C). There have been sporadic detections of explosives during LTM at Site M5. 2,4-DNT was detected at 0.78 ug/L at MW207R during October 2002. 2,4-DNT had not been detected at MW207 since August 1991. 2,6-DNT was detected at 1.8 ug/L during October 2002 and had not been detected at MW207 since July 1988. Both detections for DNT represent RG exceedances (RG = 0.42 ug/L for both DNTs). RDX was detected above the RG (2.6 ug/L) during October 2003 at a concentration of 4.9 ug/L. RDX had not previously been detected at Site M5. Since detections have been so sporadic, the Mann-Kendall statistical test analysis was not applicable.

A concentration versus time plot for TNT (Figure 6-11) and 2,6-DNT (Figure 6-12) for monitoring well MW207/MW207R indicates that contaminant concentrations have decreased over time. Given the equation to the best-fit curve for explosives compound TNT at MW207/MW207R, the compound should have naturally degraded to less than site RGs by 1992 (Table 6-1) given an initial concentration of 16.7 ug/L during 1988. TNT has not been detected at monitoring well MW207/MW207R since 1988. The estimated clean-up time for 2,6-DNT at monitoring well MW207/MW207R is two years or the year 2006. 2,6-DNT has not been detected at monitoring well MW207/MW207R since 2001.

There have been no detections of explosives at surface water sample location SWTET at Site M5 between baseline sampling conducted during July 1998 and LTM activities.

Bioparameters –TNB was detected at a concentration of 0.73 ug/L at MW207R during October 2003. TNB is a photolytic breakdown product of TNT. No TNT has been detected at the site since July 1988. Anaerobic biodegradation product 4a,2,6-DNT was detected at MW207R during May 2002. TNT had previously been detected at MW207. The presence of breakdown products indicates that conditions may be favorable for biodegradation at Site M5.

Geology – The unconsolidated deposits at Site M5 consists of surficial clays and silts with a more permeable deposit at 5 to 7 feet that ranges from sand to clayey sand to gravelly sand. This permeable layer is approximately 3 to 5 feet thick and is located over the dolomite bedrock. Depth to bedrock ranges from 10 to 17 feet (Figures 7-12 and 7-13). Fracture trace maps indicate two major fractures that intersect in the north-central portion of Site M5 and trend northeast-southwest (Figure 7-28).

Hydrogeology - Groundwater flow beneath Site M5 is to the southwest (Figures 7-7-46). The average water table depth is approximately 10.7 to 11.5 feet below ground surface (Figures 7-12 and 7-13). Potentiometric surface contours indicate that flow in the bedrock aquifer is toward the west (Figure 7-47). Water level elevations versus time plots for Site M5 monitoring wells are included in Appendix H. Monitoring well MW127R had an unusually high groundwater elevation with respect to other combined wells at the site from 1999 through 2001. This can be attributed to soil excavation work conducted at Site M5 during 1999. Soil was excavated down to the water table. Excavation activities allowed surface water runoff to accumulate in the open excavations causing temporary mounding of the groundwater. The groundwater elevation in well MW127R equilibrated between spring and fall of 2001. Other than seasonal variation, no drastic changes in groundwater elevation occurred at other site monitoring wells. Vertical gradients are unavailable due to the absence of well nests at the site. The lack of water table wells is due to very little saturated unconsolidated deposits present at the site. Unconsolidated deposits are rather thin at Site M5. Depth to bedrock ranges from 10 to 17 feet below ground surface at Site

M5 and depth to water ranges from 10.7 to 11.5 feet below ground surface. Because Site M5 is located just North of Grant Creek in a low topographic setting, vertical gradients in this area are likely upward. The average horizontal gradient and linear velocity were not calculated due to the limited number of water table wells at the site.

Surface water at Site M5 historically ran to Tetryl Ditch, which in turn discharged to Grant Creek. Surface water location SWTET has been sampled at the intersection of Tetryl Ditch and Grant Creek (Figure 7-45). No detections of explosives have been observed at SWTET since sampling started during July 1988. During construction of the Intermodial Center, Tetryl Ditch was filled in during access road construction along the south boundary of the Intermodial Center. Surface water from Site M5 now flows to a large sedimentation basin north of the access road, in the west portion of Site M5. There has been no indication of an increase in water levels in monitoring wells located adjacent to the sedimentation basin (MW354R, MW355R, MW356R and MW114R; Appendix H).

Model Results - Based on only sporadic explosives detections and only at monitoring well MW207/MW207R, no groundwater modeling was performed in support of the monitored natural attenuation remedy at Site M5.

Summary - Historically, tetryl and other explosives compounds had been detected at low levels in monitoring well MW207. Detections diminished until SOU RA activities took place during 1999. LTM monitoring results since 1999 indicate RG exceedances for RDX, 2,4-DNT, and 2,6-DNT at replacement well MW207R at Site M5. Sporadic detections of explosives are likely due to disturbance of soil during redevelopment construction activities.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. Soil OU RA activities, conducted during 1999, have removed the soil source to groundwater at Site M5. Table 7-10 lists the institutional controls implemented at Site M5. Institutional controls are effective in preventing exposure to contaminated groundwater. The groundwater remedy is protective of human health and the environment.

7.3.2.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.3.2.3 Question C: Has any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.3.3 Site M6

Site M6, the TNT Ditch Complex, includes approximately 271 acres in the central part of the MFG Area (Figure 3-1). At facility shut-down, there were 10 production lines for the manufacture of TNT. The groundwater monitoring network within this site consists of 43 wells: 18 overburden wells, 2 combined overburden/bedrock wells, and 23 bedrock wells. Monitoring well locations are shown on Figures 3-2 and 7-46. Surface water is also monitored at a point within the TNT ditch (SWTNT) near the point of discharge to Grant Creek (Figure 7-46).

7.3.3.1 Question A: Is The Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater at Site M6 was sampled for explosives, VOCs, and natural attenuation indicator parameters during October 2003 (Tables 7-4, 7-6, and 7-5, respectively). Historic data tables have been include in Appendix C. Detections of explosives and VOCs at each monitoring well sampled at Site M6 during October 2003 have been included in Figure 7-44. The extent of explosives and VOCs in groundwater have been depicted in Figure 7-45. Because of the number of wells present at Site M6, analysis has been limited to a select number of wells exhibiting the maximum observed concentrations for explosives and VOCs.

The RG for TNT (9.5 ug/L) has routinely been exceeded in monitoring wells MW210R, MW212R, MW307, and MW652 (Figures 6-13 through 6-17). The concentration of TNT at well MW210R has declined from the maximum observed concentration of 820 ug/L during July 1988 to 6 ug/L during October 2003. The Mann-Kendall statistical test indicated a decreasing trend for TNT at both an 80% and 90% confidence level (Appendix F).

On Figure 6-13, a best-fit curve is extrapolated through the TNT concentration presented on the graph. In order to get an estimate of the time required for the selected explosives compound to naturally degrade to less than site RGs, the equation to the best-fit curve on Figure 6-13 is used to project potential contaminant reduction rates. Table 6-1 summarizes the results of this analysis. Given the equation to the best-fit curve for TNT at MW210R, the estimated year at which this compound should have naturally degraded to less than site

RGs was 2000. Analytical results reveal the last TNT exceedance was during October 2001. Excavation work at Site M6 was conducted during 1999, 2002, and 2003. Soil OU RA activities required soil removal to the water table. While the excavations were open, explosives may have had an increased likelihood of impacting groundwater. Temporarily increased levels of TNT may be expected in areas affected by excavation activities.

The TNT levels in well MW212R have dropped from the maximum observed concentration of 2,600 ug/L during July 1988 to 400 ug/L during October 2003 (Figure 6-15). Mann-Kendall statistical test results indicate an increasing trend for TNT at MW212R (Appendix F). This result is expected due to excavation activities at Site M6. Monitoring well MW212R is screened in the overburden and would experience more infiltration from open excavations. In Figure 6-15, a best-fit curve is extrapolated through the TNT concentration presented on the graph. Given the equation to the best-fit curve for explosives compound TNT at MW212R, the estimated time at which this compound will naturally degrade to less than site RGs is 15 years (or in the year 2019; Table 6-1).

The TNT levels in well MW307 have declined from the maximum observed concentration of 21.6 ug/L during July 1988 to 10 ug/L during October 2003. Mann-Kendall statistical trend analysis indicated an undetermined stable trend (CV≤1). On Figure 6-15, a best-fit curve is extrapolated through the TNT concentration presented on the graph. Given the equation to the best-fit curve for explosives compound TNT at MW307, the estimated year at which this compound should have naturally degraded to less than site RGs was 2002.

The TNT levels in well MW652 have declined from the maximum observed concentration of 3,400 ug/l during June 1999 to 1,500 ug/l during October 2003 (Figure 6-17). Mann-Kendall statistical test results for TNT at MW652 indicate a stable trend (CV≤1).

Results from the October 2003 sampling event indicate RG exceedances for TNT occurred at Site M6 overburden wells MW212R, MW307, MW650, and MW652 (Table 7-4). No RG exceedances for TNT were observed in samples collected from bedrock wells at Site M6 during October 2003.

The RGs for 2,4-DNT and 2,6-DNT (0.42 ug/L for both) have routinely been exceeded in wells MW210/MW210R, MW212/MW212R, and MW652 (Figures 6-14, 6-15, and 6-17). The concentration of 2,4-DNT at MW210/MW210R has declined from the maximum observed concentration of 3,200 ug/L during July 1988 to 1.8 ug/L during October 2003. The concentration of 2,6-DNT at MW210/MW210R has declined from the highest reported concentration of 1,400 ug/L during July 1998 to 6.3 ug/L during October 2003. The Mann-Kendall statistical tests for both DNTs indicate a non-stable trend (CV>1). This test result is due to the dramatic increase in the concentration of DNTs during May and October 2001 (Appendix F). This spike in detected concentration of DNTs was not unexpected because RA activities at Site M6 were conducted during 1999. Soil OU RA activities required soil removal to the water table. While the excavations were open, explosives may have had an increased likelihood of impacting groundwater. Temporarily increased levels of DNTs may be expected in areas affected by excavation activities.

In Figure 6-14, a best-fit curve is extrapolated through the 2,4-DNT and 2,6-DNT concentrations presented on the graph. Given the equation to the best-fit curve for explosives compound 2,4-DNT at MW210R, the estimated time at which this compound will naturally degrade to less than site RGs is 2004 (Table 6-1). For 2,6-DNT the estimated time at which this compound will naturally degrade to less than site RGs is 3 years (or in the year 2007; Table 6-1).

The concentration of 2,4-DNT at MW212R has declined from the maximum observed concentration of 6,800 ug/L during May 2000 to 4,400 ug/L during October 2003. The concentration of 2,6-DNT has decreased from the maximum observed concentration of 2,800 ug/L during October 2000 to 1,500 ug/L during October 2003. Mann-Kendall statistical test results for DNTs indicated an increasing trend at an 80% confidence level for both compounds at MW212R (Appendix F). This trend can be explained by soil excavation activities being performed at the site during 1999, 2002, and 2003. In addition, DNTs are photolytic breakdown products of TNT.

The concentration of 2,4-DNT at well MW652 has decreased from 14,500 ug/L to 5,600 ug/l and 2,6-DNT decreased from 14,500 ug/L to 2,300 ug/L from June 1999 to October 2003. Mann-Kendall statistical test results indicated decreasing trends for DNTs with an 80% confidence level. On Figure 6-17, a best-fit curve is extrapolated through the 2,4-DNT concentrations presented on the graph. Given the equation to the best-fit curve for explosives compound 2,4-DNT at MW652, the estimated time at which this compound will naturally degrade to less than site RGs is 90 years (or in the year 2094; Table 6-1).

RG exceedances of one or both DNTs occurred at wells MW210R, MW212R, MW307, MW309, MW315, MW650, MW651, MW652, MW653, MW654, and MW655 during October 2003 (Table 7-4). RG exceedances for DNTs occur in both the unconsolidated deposits and bedrock aquifers.

The concentration of 2-NT has decreased from the maximum observed concentration of 68,000 ug/L during June 1999 to 23,000 ug/l during October 2003 in monitoring well MW652. Reported concentrations of 2-NT have remained above the RG of 5,100 ug/L throughout LTM activities (Appendix C). Mann-Kendall test results indicate a stable trend (CV<1) for 2-NT at well MW652 (Appendix F).

There have been no exceedances of surface water RGs (or groundwater RGs) for explosive compounds at surface water location SWTNT since inception of sampling during July 1998. The only explosive compounds detected at SWTNT have been low levels of 2a,4,6-DNT and 4a,2,6-DNT during October 2001 and May 2002. There are no RGs for 2a,4,6-DNT and 4a,2,6-DNT.

VOCs have routinely been sampled for at monitoring wells MW118, MW119, MW166R, MW311, MW312, MW320R, MW650, MW651, MW662, MW663, MW664, and MW665 during LTM at Site M6. There have been no RG exceedances for VOCs at Site M6 during

LTM activities (Appendix C). 1,1-Dichloroethane (1,1-DCA) has been detected once at wells MW166R (1.0 ug/L during May 2000) and MW320R (0.6 ug/L during May 2000) but never over the RG of 700 ug/L. Acetone has been detected once in monitoring well MW650 (10 ug/L during May 2001) and MW665 (6 ug/L during May 2003). Remaining acetone detections were qualified as having association with blank contamination. There is no RG for acetone.

Total 1,2-Dichloroethene (1,2-DCE) has been detected at well MW320R at levels ranging from 5.0 ug/L to 6.8 ug/L during LTM activities. The RG for 1,2-DCE is 70 ug/L. 1,2-Dichloroethane (1,2-DCA) was detected at MW315 at 0.7 ug/L during October 2000 and has not been detected since. The RG for 1,2-DCA is 5 ug/L. Tetrahydrofuran (THF) was detected at monitoring well MW166 at 97 ug/l and 94 ug/L during October 1999 and October 2000, respectively. There is no RG for THF. Trichloroethene (TCE) was detected at 3 ug/L at MW123 during baseline sampling in July 1998. Subsequent resampling of MW123 during December 1998 for VOCs indicated no detection of TCE. PCE was detected at 2 ug/L at well MW313 during baseline sampling in July 1998. Subsequent resampling during December 1998 indicated no detection of PCE. There have been no detections of PCE during LTM activities at Site M6. A total of 26 wells at Site M6 have been sampled for VOCs since 1998 for a total of 107 analyses. No other detections of PCE, other than the low-level estimated concentration at MW313, have occurred at Site M6.

Sulfate was detected at 460 mg/l at monitoring well MW166R, exceeding the RG of 400 mg/L, during October 2003. Monitoring wells MW651 and MW652 have exhibited increasing sulfate concentrations. Sulfate was reported at 360 mg/L and 350 mg/L at wells MW651 and MW652, respectively during October 2003 (Table 7-5).

Bioparameters –TNT anaerobic biodegradation byproducts 2a,4,6-DNT and 4a,2,6-DNT have been detected in monitoring wells MW210R, MW212R, MW307, MW308, MW309, MW314, MW315, MW650, MW652, and MW654 during LTM activities at Site M6 (Appendix C). An average concentration of 5 mg/L organic carbon was found in wells containing TNT biodegradation byproducts. The level of organic carbon is marginal to adequate to sustain biodegradation mechanisms. The groundwater appears to be mostly anaerobic with red-ox potential trending down at most site wells. There appear to be pockets of sulfidogenic activity. Monitoring wells MW308, MW309, and MW310R exhibit decreasing sulfate concentrations (Table 7-5). Nitrate depletion exists at this site similar to the LAP sites, further supporting the conclusion that anaerobic conditions exist at the site. This site is exhibiting adequate evidence of natural attenuation.

Geology – The unconsolidated deposits at Site M6 consist of surficial clays and silts with scattered deposits of permeable sand or gravel over dolomite bedrock. These permeable deposits are located predominately on the east side of the site and range from approximately 3 to 15 feet in thickness. Depth to bedrock ranges from 3 to 35 feet (Figures 7-14 through 7-18). The fracture trace map indicates a northeast-southwest pair of parallel fractures terminating on the west side of the site and another northwest-southeast trending pair terminating on the east side of the site (Figure 7-28).

Hydrogeology - Groundwater flow is to the west/southwest at Site M6 (Figure 7-46). The water table depth ranged from 3.5 to 17.6 feet below ground surface at Site M6 during October 2003 (Figures 7-14 through 7-18). Potentiometric surface contours indicate flow in the bedrock aquifer is toward the west/southwest at Site M6 (Figure 7-47). Water level elevations versus time plots for Site M6 monitoring wells are included in Appendix H. Overburden wells MW662 and MW664 and bedrock wells MW663 and MW665, installed near a large sedimentation basin along the northern boundary of Site M6, do not indicate increasing trends. Other than seasonal variation and effects from soil excavation work conducted during 1999, 2002, and 2003 at Site M6, no drastic changes in groundwater elevations have occurred at site monitoring wells.

Vertical gradients are generally downward across the site (Table 7-7). Well nests MW315/MW314 and MW318/MW319 have exhibited changes in vertical gradient direction from downward to slightly upward during recent LTM activities at Site M6. The cause of these fluctuations is possibly due to hydraulic head changes caused by soil excavation activities at the site. The vertical gradient is not readily apparent at well nests MW166R/MW320R and MW312/MW311 (Table 7-3). The average horizontal gradient during October 2003 was 0.0222 ft/ft (Table 7-8). The average horizontal gradient at Site M6 has ranged from 0.0130 ft/ft to 0.0270 ft/ft between October 1999 and October 2003 (Table 7-2). Assuming an effective porosity of 0.30, the average linear velocity during October 2003 was 0.1804 ft/day (Table 7-9). Flow velocities have ranged from 0.1056 ft/day to 0.2194 ft/day between 1999 and 2003 (Table 7 -1).

Model Results - Monitoring wells MW212R and MW315 were selected as the source locations for modeling exercise at Site M6. The July and December 1998 groundwater quality results of 4,600 ug/L and 5.2 ug/L, respectively, for 2,4-DNT were selected as the source concentrations. First order decay rate constants of 1.1E-03 yr^{-1} and 3.65E-03 yr^{-1} for 2,4-DNT were used at wells MW212R and MW315, respectively (Appendix E). Model results indicate that maximum predicted distances of RG exceedances from well MW315 (<15 ft) will remain within the GMZ (3,500 feet). The maximum predicted distance of the RG exceedance from well MW212R (<9,000 ft) may exceed the limit of the GMZ (3,500 ft). However, there are no detections of any explosives in wells MW123R or MW162R, which are approximately 2,000 ft downgradient of MW212R. Furthermore, the TNT Ditch likely acts as a surface discharge of shallow groundwater, as well as a potential surface discharge to marshy areas west of the TNT Ditch, but within the GMZ. Therefore, the conservatism of the model has likely overestimated the downgradient distance of RG exceedances for 2,4-DNT from well MW212R. Model results have been summarized in Table 6-2 and included in Appendix G.

Summary - RG exceedances for explosive compounds have been reported at six overburden, three combined overburden and bedrock, and four bedrock wells at Site M6 during LTM conducted since June 1999. Explosives compounds detected above RGs during LTM in overburden and combined wells include RDX, TNT, TNB, 2-NT, 1,3-DNB, 2,4-DNT, and 2,6-DNT. Only 2,4-DNT and 2,6-DNT have exceeded RGs in bedrock wells at Site M6 during LTM conducted since June 1999. There were no detections for explosives at surface water location SWTNT located near the confluence of TNT Ditch and Grant Creek.

Mann-Kendall statistical test results indicated an increasing trend for DNTs and TNT at monitoring well MW212R. Spikes in explosive concentrations were expected because of SOU RA activities have been conducted at the site since 1999. Excavations are conducted down to the water table surface and are left open for extended periods of time waiting on soil confirmation sample results. BIOSCREEN modeling results indicate a maximum predicted travel distance of >9000 ft for 2,4-DNT at well MW212R, or outside the GMZ boundary. However, there are no detections of explosives in wells MW123R or MW162R, which are approximately 2,000 ft downgradient of MW212R. Furthermore, the TNT Ditch likely acts as a surface discharge of shallow groundwater, as well as a potential surface discharge to marshy areas west of the TNT Ditch, but within the GMZ. Therefore, the conservatism of the model has likely overestimated the downgradient distance of RG exceedances for 2,4-DNT from well MW212R.

VOC detections have occurred at overburden wells MW166R and MW650, combined well MW311, and bedrock wells MW320R and MW665 during LTM but no RG exceedances have occurred in the five year period from June 1999 through October 2003 (Appendix C). All of the detections except 1,2-DCE at well MW320R were one-time detections at very concentrations. Detections of 1,2-DCE at MW320R have consistently been an order of magnitude below the RG (70 ug/L).

Sulfate is included in the parameter list required for the Five-Year Review of the GOU natural attenuation remedy. Sulfate exceeded the RG of 400 mg/L at well MW166R at Site M6.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. Soil OU RA activities, conducted during 1999, 2002, and 2003 have removed the soil source loading groundwater at Site M6. The groundwater remedy is expected to be protective of human health and the environment when soil RA activities are complete for source soils. Soil RA activities will be completed during fiscal year 2004. Table 7-10 lists the institutional controls implemented at Site M6. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.3.3.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used At The Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.3.3.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

A power generating station developer, Indeck, has proposed a coal-fired electric generating facility be built with the land reserved for conversion to industrial usage at the MFG area. Construction of a coal loading/unloading area along the west central boundary of Site M6 would include removal of bedrock by blasting to a depth of approximately 65 feet below ground surface. Continuous blasting required to breakup Silurian dolomite bedrock could affect the Maquoketa Shale confining unit beneath Site M6. Groundwater withdrawal or other engineered means of preventing water migration into the bedrock removal area would be required. Changes in groundwater flow at Site M6 would likely be temporary. Data should be evaluated to determine if the project would be compatible with RAOs in the ROD.

No other information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.3.4 Site M7

Site M7, the Red Water Area, situated in the central part of the MFG Area, includes approximately 49 acres, and unlike most of the other sites, is bordered on all sides by other sites (Figure 3-1). Site M7 includes a cluster of structures in the northern one third of the site, which was part of a red water treatment facility. The facility is referred to in past reports as the open storage tank. Included in the open storage tank area are three sets of storage tanks, evaporators, and incinerators. These facilities treated the effluent from the TNT production lines, which was discharged into the TNT Flume System. At one time there was a two-acre lagoon immediately north of the open storage tank area. This lagoon, which provided the extra holding capacity for red water, was removed in 1985. The monitoring well network at this site consists of four overburden wells, one combined well, and two bedrock wells (Figures 3-2 and 7-46).

7.3.4.1 Question A: Is the Remedy Functioning as Intended By the Decision Documents?

Chemistry – During the October 2003 sampling round, groundwater at Site M7 was sampled for explosives and natural attenuation indicator parameters (Tables 7-4 and 7-5). Detections of explosives at each monitoring well sampled at Site M7 during October 2003 have been included in Figure 7-44. The extent of explosives in groundwater at Site M7 has been depicted in Figure 7-45. The RG for TNT has been exceeded at well MW124R. The Mann-Kendall statistical test indicates an increasing trend for TNT at well MW124R (Appendix F). Soil OU RA excavation activities at Site M7 occurred from July through October 2001. Increasing concentrations of TNT at MW124R occurred during May 2002. The increasing trend of TNT at MW124R can be attributed to Soil OU remedial action activities at Site M7. There have been no other RG exceedances for TNT at Site M7.

The RG for 2,4-DNT has been periodically exceeded at well MW124R (Figure 6-18; Appendix C). The RG for 2,4-DNT was exceeded at wells MW124R, MW660, and MW661 during October 2003 (Table 7-4). No RG exceedances for explosives had occurred at wells MW660 and MW661 prior to October 2003. 2,4-DNT was detected at levels above the RG at well MW158 during December 2000, but has not been detected since.

The RG for 2,6-DNT (0.42 ug/L) was exceeded at MW124R during October 2002 and October 2003. Mann-Kendall statistical test results indicate a non-stable trend (CV>1) for DNTs at monitoring well MW124R. The recent RG exceedances for DNTs occurred after soil excavation activities were conducted at Site M7 during July through October 2001. DNTs are photolytic degradation products of TNT. Soil OU RAOs required soil removal at Site M7 occur to the water table. While the excavations were open, explosives had an increased likelihood of impacting groundwater. Temporarily increased levels of explosives may be expected in areas affected by excavation activities. Natural attenuation mechanisms should continue to prevent RG exceedances beyond the GMZ.

Exceedances of the RG for RDX (2.6 ug/L) have occurred at well MW124R. RDX concentrations have declined from the maximum observed concentration of 46 ug/L during November 1985 to 6.4 ug/L during October 2003 (Figure 6-18). Mann-Kendall statistical test results indicate a non-stable trend (CV>1) for RDX at well MW124R (Appendix F). RDX concentrations had dropped below detection limits during 2000 and 2001, but exceeded RGs again after soil excavation activities occurred from July through October 2001. RDX has not been detected in any other wells at Site M7. On Figure 6-17, a best-fit curve is extrapolated through the RDX concentrations presented on the graph. Given the equation to the best-fit curve for explosives compound RDX at MW124R, the estimated time at which this compound will naturally degrade to less than site RGs is 1 year (or in the year 2005; Table 6-1).

PCE was detected above the RG (5 ug/L) at monitoring well MW124 during November 1985 (Appendix C). Subsequent resampling of well MW124R during August 1991 and December 1998 resulted in detections of 4 ug/l and 3.6 ug/L, respectively. Monitoring well MW124R has not been sampled for VOCs since December 1998. The estimated time for PCE to drop below the RG at MW124R was 1997 (Table 6-1).

1,1,1-Trichloroethane (1,1,1-TCA) was detected at levels above the RG (200 ug/L) at well MW124 during 1981 and at levels below the RG during 1985 and 1991 (Appendix C).

Subsequent resampling of MW124R for VOCs during baseline activities in December 1998 indicated no detection of 1,1,1-TCA.

Bioparameters – TNT biodegradation daughter products 2a,4,6-DNT and 4a,2,6-DNT have routinely been detected at Site M7 well MW124R. Organic carbon was reported at 13 mg/L at well MW124R during October 2003. The reported level of organic carbon is adequate to sustain biodegradation. Dissolved oxygen levels remained below 1.0 mg/L during October 2003, indicating an anaerobic environment at Site M7. In addition, evidence of denitrification occurring at well MW124R is supported by nitrate reduction rates at this well. Because of the significant contaminant reductions and the presence of anaerobic biodegradation products of TNT (2a,4,6-DNT and 4a,2,6-DNT), Site M7 is considered to have adequate potential for biodegradation of explosives compounds.

Geology – The unconsolidated deposits at Site M7 consist primarily of surficial clays. Depth to bedrock ranges from 5 to 13 feet (Figures 7-19 and 7-20). No significant bedrock fracture traces are shown on the fracture trace maps for Site M07 (Figure 7-28).

Hydrogeology - Groundwater flow is to the west/southwest at the site (Figures 7-46). The water table depth ranged from 3.2 to 7 feet below ground surface during October 2003 (Figures 7-19 and 7-20). Flow in the bedrock at Site M7 is toward the west/northwest (Figure 7-47). Water level elevations versus time plots for Site M7 monitoring wells are included in Appendix H. The plots indicate low water elevations during October 1999 and October 2002. Water levels returned to normal during the following spring on each occasion.

Observed vertical gradients during October 2003 indicated downward gradients in the northern portion of the site and slightly upward gradients in the southern portion of Site M7 (Table 7-7). Vertical gradients have switched directions at all well nests at Site M7 during LTM activities (Table 7-3). The average horizontal gradient during October 2003 was 0.0116 ft/ft (Table 7-8). Horizontal gradients have ranged between 0.0096 ft/ft and 0.0144 ft/ft during LTM activities from 1999 through 2003 (Table 7-2). Assuming an effective porosity of 0.30, the average linear velocity during October 2003 was 0.0734 ft/day (Table 7-9). Linear velocities have ranged from 0.0608 ft/day to 0.0747 ft/day during LTM activities at Site M7 (Table 7-1).

Model Results - Monitoring well MW124R was selected as the source location for the model. The July 1998 2,4-DNT detection (2.6 ug/L) was selected as the source concentration. The model results indicate that the maximum predicted distance of RG exceedances (<5 feet) will remain within the GMZ (2,300 feet). Model results have been summarized in Table 6-2 and included in Appendix G.

Summary - Groundwater samples from LTM at Site M7 indicate RG exceedances for explosive compound 2,4-DNT occurred at overburden well MW660 and bedrock wells MW158 and MW661. The remaining RG exceedances for RDX, TNT, TNB, 2,4-DNT, and 2,6-DNT occurred at combined well MW124R. Mann-Kendall statistical test results indicate an increasing trend for TNT at monitoring well MW124R. BIOSCREEN modeling results indicate a maximum predicted travel distance of <5 ft for 2,4-DNT at MW124R. Sulfate exceeded the RG (400 mg/L) at well MW159 during October 2003. SOU RA activities were conducted at Site M7 between July and October 2001. Recent (May 2002 through October 2003) RG exceedances for explosive compounds are likely attributed to SOU RA activities.

The technical assessment indicates that the remedy is functioning as intended by the decision documents. Soil OU RA activities, conducted during 2001 have removed the soil source loading groundwater at Site M7. Table 7-10 lists the institutional controls implemented at Site M7. Institutional controls are effective in preventing exposure to contaminated groundwater. The groundwater remedy is protective of human health and the environment.

7.3.4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.3.4.3 Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.3.5 Site M8

Site M8 – The Acid Manufacturing Area, includes approximately 304 acres immediately east of TNT Road (Figure 3-1). Site M8 included facilities for the manufacture and storage of nitric and sulfuric acids. In addition to an extensive network of piping, many ASTs and USTs were also present. The monitoring wells at this site consist of four overburden wells, and two combined wells (Figures 3-2 and 7-46).

7.3.5.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater from Site M8 was sampled for explosives, VOCs, and natural attenuation indicator parameters (Tables 7-4, 7-6, and 7-5, respectively) during October

2003. Detections of explosives and VOCs at each monitoring well sampled at Site M8 during October 2003 have been included in Figure 7-44. No RG exceedances of explosives or VOCs were identified. However, the reported sulfate concentrations at Site M8 wells MW148RR (470 ug/L), MW325R (690 mg/L), and MW330 (500 mg/L) exceeded the RG of 400 mg/L (Table 7-5). Historically, sulfate RG exceedances occurred at monitoring wells MW360 and MW361.

Historically, an exceedance of the RG for 2,6-DNT (0.42 ug/L) occurred at monitoring well MW325 (0.531 ug/L) during October 1991 (Appendix C). Subsequently, no detections of 2,6-DNT have occurred during LTM activities at MW325R. No other exceedances of explosives RGs have occurred at Site M8. Low levels of 2a,4,6-DNT and 4a,2,6-DNT were detected at MW325R during the fall of 1999, 2001, and 2003. There are no RGs for these compounds.

VOCs including 1,1,1-TCA, 1,1-DCA, 1,2-DCE, methyl ethyl ketone (MEK), acetone, ethyl benzene, PCE, toluene, TCE, xylenes, vinyl chloride, and methylene chloride; have historically been detected at Site M8 (Appendix C). Exceedances of RGs have only occurred for PCE and vinyl chloride. PCE was reported at concentrations greater than the RG (5 ug/L) during December 1994 and May 2000 at well MW148RR. Seven consecutive rounds of LTM have been conducted since the last RG exceedance for PCE at MW148RR and PCE has not been detected. On Figure 6-19, a best-fit curve is extrapolated through PCE concentrations presented on the graph. Given the equation to the best-fit curve for PCE, the estimated year at which this compound should have naturally degraded to less than the site RG was 2003. Vinyl chloride exceeded the RG (5.0 ug/L) at well MW327R during June 1999, October 2000 and May 2001. Four consecutive rounds of LTM since May 2001 have indicated no detections of vinyl chloride at well MW327R.

1,2-DCE has been detected at monitoring well MW327R at levels less than the RG of 70 ug/L. Concentrations have decreased from the maximum observed concentration of 34 ug/L during October 1999 to no detection since May 2002 (Appendix C). 1,1-DCA and 1,1,1-TCA have been detected at wells MW148RR and MW323R but levels remain below RGs (700 ug/L and 200 ug/L, respectively). The remaining VOC detections are sporadic with little to no reproducibility among sampling events.

Bioparameters – Site M8 has had reported detections of TNT anaerobic degradation byproducts 2a,4,6-DNT and 4a,2,6-DNT at well MW325R. In addition, wells MW148RR and MW323R have exhibited declining concentrations of 1,1,1-TCA and the presence of its biodegradation product 1,1-DCA. Little organic carbon was found at Site M8 (average of 3.1 mg/L) during October 2003 that could sustain biodegradation mechanisms. Monitoring wells MW323R and MW325R exhibit declining concentrations of organic carbon, indicating active biological activity at the site. The groundwater appears to be mostly anaerobic with pockets of sulfidogenic activity. More nitrate depletion exists at this site than at LAP sites, further supporting the conclusion that anaerobic conditions exist at the site. This site is exhibiting adequate baseline evidence of natural attenuation.

Geology – The unconsolidated deposits at Site M8 consist of silty clays, silty sands and silts with occasional deposits of permeable sand or gravel over dolomite bedrock. Depth to bedrock ranges from 13 to 18 feet (Figures 7-21 and 7-22). Fracture trace maps indicate two major bedrock fractures that intersect at the central portion of Site M8 and trend northeast-southwest and northwest-southeast. Two additional parallel fractures that trend northeast-southwest are located in the northern portion of Site M8 (Figure 7-28).

Hydrogeology - Groundwater flow is to the southwest in the southern and northern portions of site M8. A groundwater high was present in the central portion of the site around monitoring well MW325R, adjacent to areas of excavation at Site M6 (Figures 7-46) during October 2003. The water table depth ranged from 8.7 to 15.9 feet below ground surface during October 2003 (Figures 7-21 and 7-22). No potentiometric surface information is available for Site M8 due to the lack of bedrock wells at the site (Figure 7-47). Water level elevations versus time plots for wells at Site M8 are included in Appendix H. The plots indicate a decreasing trend in water elevations at wells MW148RR and MW324R. These wells are located within the Intermodial Center, which is part of the Industrial Park property transferred to the State of Illinois. The area has had extensive asphalt paving, which is likely decreasing groundwater recharge in that area.

Vertical gradient information is unavailable due to the absence of well nests at the site. The average horizontal gradient during October 2003 was 0.0004 ft/ft (Table 7-8). Horizontal gradients have ranged from 0.0003 ft/ft to 0.0143 ft/ft (Table 7-2) between October 1999 and October 2003. The average linear flow velocity at Site M8 during October 2003 was 0.0009 ft/day (Table 7-9). Linear flow velocities have ranged from 0.0006 ft/day during October 2001 to 0.0401 ft/day during October 2000 (Table 7-1) at Site M8.

Model Results – Based on the absence of any RG exceedances, no groundwater modeling is required in support of the monitored natural attenuation remedy.

Summary - There have been no RG exceedances for explosives compounds at Site M8 during LTM activities (June 1999 through October 2003). VOC exceedances occurred at well MW148RR during May 2000 for PCE and vinyl chloride at MW327R during June 1999, October 2000, and May 2001. Seven consecutive rounds of VOC analytical data at MW148RR since May 2000 do not indicate detection of PCE above the detection limit (5 ug/L). Vinyl chloride has not been detected above the detection limit (5 ug/L) for three consecutive sampling rounds since May 2001. VOCs 1,1-DCA, 1,1,1-TCA, and 1,2-DCE have been detected at well MW323R and 1,1-DCA and 1,1,1-TCA at well MW148RR, but levels have consistently been a minimum of an order of magnitude below RGs. Sulfate exceeded the RG of 400 mg/L at wells MW148RR, MW325R, and MW330 during October 2003.

The technical assessment indicates that the remedy is functioning at Site M8 as intended by the decision documents. Table 7-10 lists the institutional controls implemented at Site M8. Institutional controls are effective in preventing exposure to

groundwater. The groundwater remedy is protective of human health and the environment.

7.3.5.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.3.5.3 Question C: Has any Other Information Come to Light that Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.3.6 Site M13

Site M13, the Gravel Pits, is located southwest of the Acid Manufacturing Area, and covers approximately 106 acres (Figure 3-1). It includes four areas that served as sources of sand and gravel fill, and as a site for waste dumping. Well abandonment and replacement activities took place at Site M13 during January 2004. The monitoring well network at the site now consists of two overburden wells, one combined well, and four bedrock wells (Figure 4-1).

7.3.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry – Groundwater was sampled for explosives and natural attenuation indicator parameters (Table 7-4 and 7-5, respectively) for the Five-Year Review sampling event conducted during October 2003 at Site M13. The extent of explosives in groundwater has been depicted in Figure 7-45. The RG for 2,4-DNT (0.42 ug/L) has been routinely exceeded at well MW321 (Figure 6-20). Concentrations of 2,4-DNT have declined from the maximum observed concentration of 120 ug/L during October 1991 to 47 ug/L during October 2003. Mann-Kendall statistical test results indicated a stable trend ($CV \leq 1$) with an 80% confidence level. The data for MW321 were corrected for seasonal variations (Appendix F). On Figure 6-120, a best-fit curve is extrapolated through the 2,4-DNT concentrations presented on the graph. Given the equation to the best-fit curve for explosives compound 2,4-DNT at MW321, the estimated time at which this compound will naturally degrade to less than the site RG is 39 years (or in the year 2043; Table 6-1).

Similarly, Figure 6-21 had a best-fit curve extrapolated through the data for 2,4-DNT detections at MW350. The estimated time at which 2,4-DNT will degrade to less than the site RG is 1 year (or in the year 2005; Table 6-1; Appendix D).

The RG for 2,6-DNT has routinely been exceeded at MW321 (Figure 6-20). Concentrations have decreased from the maximum observed concentration of 34 ug/L during October 1999 to 22 ug/L during October 2003 (Appendix C). Mann-Kendall statistical test results indicate a decreasing trend for 2,6-DNT at MW321 with an 80% confidence level. The RG for 2,6-DNT was exceeded at well MW350 during October 2000, but six subsequent rounds of LTM have indicated no detections of 2,6-DNT.

An exceedance of the RG for TNB (5.1 ug/L) occurred at monitoring well MW321 during October 1999. Eight subsequent rounds of LTM failed to detect TNB above method reporting limits. There have been no other exceedances of RGs for explosive compounds at Site M13 during LTM activities.

Bioparameters – TNT anaerobic degradation byproducts 2a,4,6-DNT and 4a,2,6-DNT have routinely been detected at site monitoring wells MW126, MW321, and MW350 during LTM activities at Site M13. The groundwater appears to be mostly aerobic except in the vicinity of monitoring well MW321. The dissolved oxygen reading at MW321 during October 2003 was 0.7 mg/L, indicating an anaerobic environment. Nitrate depletion rates at MW321 have been significant. In, addition, there is evidence of sufidogenic activity at Site M13 based on the detection of sulfide at 4 mg/L at MW350 during October 2003 and declining concentrations of sulfate at MW321. Sulfate has declined from 202 mg/L during October 1991 to 64 mg/L during October 2003 at MW321. This site is exhibiting adequate evidence of natural attenuation of explosive compounds.

Geology – The unconsolidated deposits at Site M13 consist of silty clays, silty sands, silts, and sands. Some of the sand deposits are up to 15 feet thick in the southern portion of the site. Depth to bedrock ranges from 19 to 34 feet (Figure 7-23). The fracture trace map indicates three small bedrock fractures located in the southern portion of Site M13. The fractures generally trend northeast-southwest (Figure 7-28). Two additional parallel bedrock fractures that trend northeast-southwest are located in the northern portion of Site M8.

Hydrogeology - Groundwater flow is generally to the southwest at the site. However, the presence of a former gravel pit in the northern portion of the site appears to provide additional recharge to the water table, creating a slight southern component of flow on the south side of the pit (Figure 7-46). The water table depth ranged from 16 to 18.6 feet below ground surface during October 2003 (Figure 7-23). No potentiometric surface information is currently available for Site M13 due to the lack of bedrock well data at the site (Figure 7-47). Replacement well activities during January 2004 resulted in the installation of two bedrock wells (MW362 and MW364) and two previously installed bedrock wells (MW321 and MW322) still exist at Site M13. In addition, combined well MW350 is also partially screened in bedrock. The bedrock wells have sufficient spatial distribution so as to produce a representative potentiometric surface map in the future for the site. In addition, numerous bedrock control points exist at Site M6 near the eastern boundary with Site M13 (MW213R, MW215R, MW308, MW314, MW315, and MW310R). Water level elevations versus time plots for wells at Site M13 are included in Appendix H. Other than seasonal fluctuations, no trends in elevations were discernible.

The vertical gradient at well nest MW321/MW322 was downward during October 2003 (Table 7-7). The vertical gradient at well nest MW321/MW322 was upward during October 2001. No gradient was observed during October 2000, but the vertical gradient has remained downward during the last two years of LTM (Table 7-3). The average horizontal gradient at Site M13 during October 2003 was 0.0068 ft/ft (Table 7-8). Horizontal gradients at Site M13 have ranged from 0.0033 ft/ft to 0.0068 ft/ft during LTM activities (Table 7-2). Assuming an effective porosity of 0.30, the average linear velocity during October 2003 was 5.1388 ft/day (Table 7-9). Flow velocities have ranged from 2.4938 ft/day to 5.1388 ft/day at Site M13 during LTM activities (Table 7-1).

Model Results - Monitoring well MW321 was selected as the source location for the model. The July 1998 2,4-DNT result (63.1 ug/L) was selected as the source concentration. A first order decay rate constant of 7.30E-02 yr^{-1} was used for 2,4-DNT. The first order decay rate constant is based on LTM analytical data (Appendix E). The model results indicate the maximum predicted transport distance of RG exceedances (<1,200 feet) will remain within the GMZ (3,200 feet). Model results have been summarized in Table 6-2 and included in Appendix G.

Summary - Monitoring well MW126, formerly a combined overburden/bedrock well, was replaced as an overburden well (MW126R) during January 2004. Monitoring well MW362 was installed as a nested bedrock well with MW126R. Monitoring wells M3 and MW345, act as early warning wells at Site M13, have been abandoned and replaced with well nest MW363/MW364. Exceedances of the RG for 2,4-DNT and 2,6-DNT occurred at in-plume combined well MW350. In addition, RG exceedances occurred for 2,4-DNT, 2,6-DNT, and TNB at in-plume bedrock well MW321. Mann-Kendall statistical test results indicate stable trends (CV<1) for TNT and 2,4-DNT and a decreasing trend for 2,6-DNT at monitoring well MW321. BIOSCREEN modeling results indicate a maximum predicted transport distance of RG exceedances for 2,4-DNT of <1200 ft. There were no detections for explosives at early warning wells (M3 and MW345) during LTM conducted from 1999 through 2003 (Appendix C).

The technical assessment indicates that the remedy is functioning at Site M13 as intended by the decision documents. The groundwater remedy is expected to be protective of human health and the environment when soil RA activities are completed at the site. Soil RA activities are scheduled to occur during fiscal year 2007. Table 7-10 lists the institutional controls implemented at Site M13. Institutional controls are effective in preventing exposure to contaminated groundwater.

7.3.6.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.3.6.3 Question C: Has any Other Information Come to Light that Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.4 GRU3 – VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER

GRU3 is entirely in the MFG Area and consists of separate plumes emanating from sources at Sites M3 and M10 (Figure 3-2). The following discussions are a summary of the LTM groundwater quality results along with a summary of site characteristics. The purpose of these summaries is to evaluate whether the monitored natural attenuation remedy is performing adequately at each site.

7.4.1 Site M3

Site M3 – Flashing Grounds, consist of a 66-acre tract in the west central part of the MFG Area (Figure 3-1). The Flashing Grounds were used to flash burn equipment to remove explosive residues. Monitoring wells at the site consist of eleven shallow bedrock wells and one combination well. The Site M3 outline and the monitoring well locations are shown on Figures 3-2 and 7-48. Site M3 was included in GRU3 because benzene was detected in well MW233 at a concentration exceeding the RG during August 1991. The USEPA and IEPA have approved the suspension of sampling at wells in Site M3 during the LTM until soil excavation activities are completed based on no detections of benzene, toluene, ethyl benzene, and xylenes (BTEX) at wells within site M3.

7.4.1.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry - Groundwater at the M3 Site was last sampled for VOCs during October 1999. No RG exceedances (no detections) of VOCs were identified. Historically, benzene has exceeded the RG (5 ug/L) at well MW233 (Appendix C). Monitoring wells MW112 and

MW113 are sampled for explosives as compliance wells for Site M7. No detections of explosives have occurred at these sampling locations during LTM activities. An exceedance of the RG for 1,3-Dinitrobenzene (1,3-DNB; 10 ug/L) occurred at well MW233 during July 1988. Subsequent resampling of the well during August 1991 indicated no detection of 1,3-DNB.

Bioparameters – Because there were no detected contaminants at this site, the evaluation of bioparameters was not necessary.

Geology – The unconsolidated deposits at Site M3 consist of clay and silt with some thin sand, and sand and gravel deposits. Depth to bedrock ranges from 2 feet to 10 feet (Figures 7-24 and 7-25) at Site M3. The fracture trace map indicates the presence of one bedrock fracture trending northwest-southeast, located beneath the southeast portion of Site M3 (Figure 7-28).

Hydrogeology - Groundwater flow in the bedrock is to the northwest at Site M3 (Figure 7-48). Water table elevations could not be contoured for Site M3 due to the lack of water table wells at the site. Because depth to bedrock ranges from 2 to 10 feet below ground surface (BGS) at Site M3 and depth to water ranges from approximately 9 to 12 feet BGS, installation of wells strictly as water table wells at Site M3 would not be practicable. Figures 7-24 and 7-25 illustrate the thin unconsolidated deposits at Site M3. No vertical gradients or horizontal gradients were calculated for the site due to the lack of data.

Model Results - Based on the absence of any RG exceedances (no detections) for VOCs at Site M3, no groundwater modeling was completed in support of the monitored natural attenuation remedy.

Summary - Site M3 was included in GRU3 because benzene was detected at well MW233 at a concentration exceeding the Class I Groundwater standard in the past. Two LTM events conducted during June and October 1999 showed no groundwater VOC RG exceedances at well MW233. Groundwater monitoring was suspended at the site following the October 1999 sampling event until SOU RA activities are conducted. Bedrock well MW233 should be sampled for VOCs semiannually for one year following SOU RA activities. Compliance bedrock well MW352 should be sampled once after SOU RA activities are completed and again if detections of VOCs occur at MW233. When no detections for VOCs occur at site monitoring wells, the site can be recommended for closure.

The technical assessment indicates that the remedy is functioning at Site M3 as intended by the decision documents. Table 7-10 lists the institutional controls implemented at Site M3. Institutional controls are effective in preventing exposure to groundwater. The groundwater remedy is protective of human health and the environment.

7.4.1.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.4.1.3 Question C: Has any Other Information Come to Light that Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

7.4.2 Site M10

Site M10 - The Toluene Tank Farms, are located in the northern portion of the MFG Area (Figure 3-1) and consisted of three AST farms. The ASTs were used for storing toluene through 1976. The Western and Central Toluene Tank Farms and their monitoring well locations are shown on Figures 3-3 and 3-4, respectively. Each facility is less than 10 acres in size, and originally included four tanks, each enclosed by a berm. The western tank farm was hit by lightning on two occasions; one tank was destroyed in 1970 and another was destroyed in June 1971. Both of the tanks exploded, burned, and were subsequently removed.

7.4.2.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Chemistry: VOC concentrations at Site M10 wells have been less than site RGs since 1998. Groundwater monitoring conducted at Site M10 during 1998, 1999, and 2000 at monitoring wells MW224 and MW220 indicated no detections of toluene. All of the RAOs set in the ROD for Site M10 have been met and the remedy is protective of human health and the environment. The Final Site M10 Closure Report was submitted and accepted in March 2003.

Geology: The subsurface geology at Site M10 West is depicted in cross-section A-A' (Figure 7-26). The overburden aquifer consists of silty clay, which is approximately 5-feet thick. The subsurface geology at Site M10 Central is depicted in cross-section A-A' (Figure 7-27). The overburden aquifer primarily consists of silty clay, with some sandy silt and clay. None of the borings at M10 Central reached bedrock, therefore the overburden thickness is unknown.

Hydrogeology: Monitoring wells at Site M10 were abandoned during March 2001.

Site M10 has been closed. Table 7-10 lists the institutional controls implemented at Site M10. Institutional controls are effective in preventing exposure to groundwater. The groundwater remedy is protective of human health and the environment.

7.4.2.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Still Valid?

A review of the exposure assumptions, toxicity data, and cleanup levels were reviewed and there were no significant changes that were found that would affect the groundwater RGs presented in the ROD (refer to Appendix I). In addition, the RAOs that were originally selected are still considered appropriate.

7.4.2.3 Question C: Has any Other Information Come to Light that Could Call Into Question the Protectiveness of the Remedy?

No information is available to call into the question the protectiveness of the remedy. A summary of the results of the review of the groundwater RGs presented in the ROD and land use conditions applicable to the site are summarized in Appendix I. The groundwater RGs presented in the ROD are still considered health protective, and groundwater monitoring has shown no exceedances of the groundwater RGs outside of the GMZ. Controls adequately prevent exposure to the groundwater with in the GMZ.

8

8.0 ISSUES

Issues	Affects Protectiveness (Y/N)	
	Current	Future
All Sites – Numerous wells are experiencing drawdown while conducting low-flow sampling because the aquifer cannot produce water at a rate equivalent to the purge rate (100 mL/min). Because drawdown is occurring at these locations, varying amounts of water from the standing water column are being sampled. A small-scale study is recommended to determine if wells experiencing drawdown are providing representative groundwater samples. About 10 to 20% of the wells which exhibit drawdown should be sampled using low-flow sampling techniques and conventional sampling by bailing or pumping dry and then collect samples within 24 hours of sufficient recharge. The samples should be collected during the same sampling event for best comparative analysis. Relative percent differences (RPDs) should be calculated between the two analyses to determine if the sampling technique should be altered for wells exhibiting drawdown during low-flow sampling.	N	N
Site M1 – In plume and early warning monitoring wells downgradient of the ash pile are exhibiting increasing concentrations of sulfate. SRU6 soil removal is the proposed remedy at Site M1. Since ash is in contact with groundwater at this site, removal of the waste should reduce contaminant loading to the groundwater. RA activities are scheduled to occur during fiscal year 2008. To date, no confirmed RG exceedances for sulfate in groundwater or surface water have occurred since expanding the GMZ.	N	Y
Site M5 – Surface water sample location SWTET no longer receives surface water from Site M5. Surface water now runs to a large sedimentation basin southwest of the site due to redevelopment of the area surrounding Site M5. Sampling at SWTET should be discontinued. Sampling of the sedimentation basin should be conducted for explosives.	N	N
Site M6 – The ROD indicates that cadmium was detected at concentration greater than the RG (5 ug/L) at monitoring well MW123 at Site M6 during 1982. No additional sampling of cadmium at MW123R (replacement well) has occurred since 1982.	Y	Y
Site M7 – PCE was detected at a concentration of 3.6 ug/L at monitoring well MW124R during December 1998. PCE exceeded the RG at well MW124 during November 1985. Monitoring well MW124R has not been sampled for VOCs since December 1998.	Y	Y
Site M8 – Sulfate exceeded the RG at monitoring wells MW360 and MW361 during 1992 and 1994. Both monitoring wells have been destroyed. Monitoring well MW361 was replaced in 1998. Monitoring well MW361R will be sampled for sulfate if the well is still functional.	Y	Y
Site M13 – Seven monitoring wells were damaged or destroyed during redevelopment activities at Site M13. Four of the original wells could not be properly abandoned because they could not be located. Wells not properly abandoned could create conduits for residual or future contamination. Measures need to be implemented to ensure that sites undergoing land transfer do not have monitoring networks damaged by redevelopment activities.	Y	Y

Issues	Affects Protectiveness (Y/N)	
	Current	Future
Transferred Properties – Interviews were not conducted with new owners, operators, or managers of transferred property to determine if new site operations are compliant with institutional controls set by the ROD. Additional information could be obtained regarding possible changes to assumptions regarding receptors and if evidence of additional contamination have been identified. In addition, provisions should be made to protect monitoring wells from destruction on transferred properties.	Y	Y

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations for issues identified in Section 8 of this report include performing a field study to determine if monitoring wells exhibiting drawdown during low-flow sampling provide representative groundwater samples. Monitoring wells screened in cohesive silt and clay soils can not produce water equal to the pumping rate (100 mL/min) recommended for low-flow sampling. It is unknown if the water quality of stagnant water located in monitoring well riser pipes is being affected by exposure to atmospheric conditions (i.e. riser open to the atmosphere). It is evident that some of this water is being sampled in wells exhibiting drawdown during low-flow sampling. In an effort to determine if these samples are representative of actual groundwater conditions, it is proposed that a defined number of wells be sampled using low-flow techniques and be purged dry using a bailer or pump and sampled when sufficient recharge required for sampling occurs. Monitoring wells that historically have had detections are preferred for the field study. A comparison of analytical results should be made to determine if sampling technique should be altered for wells exhibiting drawdown while low-flow sampling.

Additional follow-up actions include:

- Continuation of semi-annual monitoring at Site M1 due to an increasing trend for sulfate at some site monitoring wells.

- Transfer the surface water sample location SWTET from its present location to the new sedimentation basin located in the west central portion of Site M5 and continue to analyze for explosives.

- Sample monitoring well MW123R at Site M6 for dissolved cadmium.

- Sample monitoring well MW124R at Site M7 for VOCs.

- Sample monitoring wells MW361R at Site M8 for sulfate.

- For Site M13 and other transferred properties, perform interviews with new owners, operators, or managers to ensure deed restrictions are being followed and institutional controls implemented at the sites are still effective.

Monitoring well MW124R should be sampled for VOCs over two consecutive sampling events. If no detections for VOCs occurs, the need for further sampling should be evaluated.

The same sampling scheme should be followed for surface water sampling for explosives at the sedimentation basin at Site M5. The sedimentation basin is the new surface water compliance point for the site since development activities have altered the flow of surface water. This surface water location should be sampled until groundwater and surface water RGs for explosives have been met and Site M5 is closed.

Interviews should be performed with new owners, operators, or managers of transferred properties. Interviews should be performed to allow for collection of any new information regarding site operations, evidence of contamination or possible changes to assumptions regarding receptors.

Seven monitoring wells were recently damaged during redevelopment activities at Site M13. Four could not be properly abandoned and could potentially create conduits for residual or future contamination. Land transfer documentation includes an acknowledgement form signed by landowners that monitoring well networks must be protected. In addition, land use restrictions and covenants and monitoring well restrictions and covenants for the property are specifically addressed in the deed. Language could be included that specifies consequences for not meeting deed requirements.

The Army and USACE are responsible for groundwater and surface water sample collection. MWH is currently under contract with the USACE to collect groundwater and surface water samples at GRUs identified in the ROD. IEPA and EPA are the agencies with oversight authority. Proposed follow-up actions should be initiated during the Spring 2004 monitoring event.

10.0 PROTECTIVENESS STATEMENT(S)

The limited action remedy, monitored natural attenuation, was chosen for the three GRUs in the GOU.

10.1 GRU1 (SITES L1, L2, L3, AND L14)

The remedy for GRU1 remains protective of human health and the environment. Threats at the sites are being addressed through monitored natural attenuation and implementation of institutional controls. SOU RA activities will likely reduce the predicted clean-up times required for contaminant levels in groundwater to drop below RGs.

10.2 GRU2 (SITES M1, M5, M6, M7, M8, AND M13)

The remedy for GRU2 remains protective of human health and the environment. Threats at the sites are being addressed through monitored natural attenuation and implementation of institutional controls. SOU RA activities have recently been completed at sites M5 (1999) and M7 (2001). Site M6 RA activities will likely be completed during the 2004 construction season. SOU RA activities will likely reduce the predicted clean-up times required for contaminant levels in groundwater to drop below RGs. RAOs in the ROD have been fulfilled for Site M8 based on analytical results from the last three semiannual monitoring events.

10.3 GRU3 (SITES M3 AND M10)

Threats at Site M3 have been addressed through monitored natural attenuation and implementation of institutional controls. The remedy for Site M3 remains protective of human health and the environment. RAOs set in the ROD will be fulfilled when SOU RA activities are conducted at the site.

All of the RAOs set in the ROD for Site M10 have been met and the remedy is protective of human health and the environment. The Final Site M10 Closure Report was submitted in March 2003.

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11.0 NEXT REVIEW

The next Five-Year Review will cover the timeframe from May 5, 2004 through May 4, 2009.

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TABLES

Table 4-1

Summary of Groundwater Operable Unit Annual Long-Term Monitoring Operational Costs
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Year	Annual Cost of Operation[1]	Percent of Total
1999	526,900	31.7
2000	429,100	25.8
2001	432,000	26.0
2002	275,500	16.6
2003	364,200[2]	18.0
	Total $ = 1,666,300	100

1) Annual Costs include:
   A) Semi-annual groundwater monitoring at all GOU sites
   B) Preparation of Spring Semi-annual Groundwater Monitoring Report
   C) Preparation of Fall Annual Groundwater Monitoring Report
   D) Maintenance of groundwater monitoring network
2) Value represents budgeted costs. Actual costs were not available at time of report preparation.
   Budget also includes preparation of the Five-Year Review Report and items listed in footnote No. 1.

Table 6-1
Summary of Groundwater Trends: Estimated Clean-Up Time
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Site	Critical Monitoring Well	Critical Compound	Initial (1) Concentration (ug/L)	Date of Initial Concentration	Final Concentration (ug/L) (Remediation Goal - RG)	Record of Decision (ROD) Estimated Clean-Up Time for the Site (yrs)	First Five-Year Review Estimated Clean-Up Time (yrs)	First Five-Year Review Estimated Clean-Up Date (yr)	Anticipated Soil Source Removal Completion Date
LAP AREA									
L1	MW131	2,4,6-TNT	4710	1981	9.5	340	**402**	**2406**	2005
	MW131	1,3,5-TNB	4670	1998	5.1	340	87	2091	2005
	MW172	2,4,6-TNT	40.8	1983	9.5	340	-8	1996	2005
	MW173	2,4,6-TNT	105	1985	9.5	340	14	2018	2005
L2	MW404	RDX	640	1991	2.6	20	**37**	**2041**	2006
L3	MW412	RDX	210	2001	2.6	50	**27**	**2031**	2006
L14	MW508	RDX	840	1993	2.6	80	9	2013	2005
	MW511	RDX	340	1995	2.6	80	**24**	**2028**	2005
	MW512	RDX	260	1999	2.6	80	20	2024	2005
MANUFACTURING AREA									
M1	multiple wells	Sulfate	no downward trend observed due to M1 source contribution			50		NA	2008
M3	MW233	1,3-DNB	24.5	1988	10	50	**-15**	**1989**	2005
M5	MW207MW207R	2,4,6-TNT	16.7	1988	9.5	50	-12	1992	1999
	MW207/MW207R	2,6-DNT	5.58	1988	0.42	50	**2**	**2006**	1999
M6	MW210R	2,4-DNT	3200	1988	0.42	50	0	2004	2004
	MW210R	2,6-DNT	1400	1988	0.42	50	3	2007	2004
	MW210R	2,4,6-TNT	820	1988	9.5	50	-4	2000	2004
	MW212R	2,4,6-TNT	2600	1988	9.5	50	15	2019	2004
	MW307	2,4,6-TNT	21.6	1991	9.5	50	-2	2002	2004
	MW652	2,4-DNT	14500	1999	0.42	50	**90**	**2094**	2004
M7	MW124R	RDX	46	1985	2.6	50	**1**	**2005**	2001
	MW124R	PCE	6	1985	5	50	-7	1997	2001
M8	MW148	PCE	7	2000	5	50	**-1**	**2003**	NA
M10	MW220	Toluene	20000	1991	1000	50	**-9**	**1995**	NA
	MW224	Toluene	20000	1988	1000	50	-13	1991	NA
M13	MW321	2,4-DNT	120	1991	0.42	50	**39**	**2043**	2007
	MW350	2,4-DNT	43	1991	0.42	50	1	2005	2007

Note:

Estimated clean-up times are approximate and are based on constant contamination reduction rates for a specific compound at a specific point within the aquifer.

NA = Not Available/Not Applicable

Bolded value represents the longest estimated cleanup time for the associated site.

Footnote

(1) Initial concentration is the maximum observed concentration.

Table 6-2

Summary of BIOSCREEN Model Results

First Five-Year Review Report

Groundwater Operable Unit

Joliet Army Ammunition Plant

Wilmington, Illinois

Site	Well	Contaminant	Initial Concentration (ug/L)	RD/RA Decay Rate (1/yr)	First Five-Year Review Decay Rate (1/yr)	Remedial Goal (ug/L)	RD/RA Transport Distance to Reach RG (ft)	First Five-Year Review Transport Distance to Reach RG (ft)
L1	MW131	1,3,5-TNB	4670	3.65E-03	1.10E-01	5.1	<1000	<300
L2	MW404	RDX	357(1)	2.97E-03	1.10E-01	2.6	<1500	<750
L3	MW412	RDX	200(2)	2.97E-03	1.46E-01	2.6	<35	<480
L14	MW508	RDX	462	2.97E-03	2.92E-01	2.6	<1500	<600
M6	MW212R	2,4,-DNT	4600	NA(3)	1.10E-03	0.42	<5,000	<9000
M6	MW315	2,4,-DNT	5.2	NA	3.65E-03	0.42	<5	<15
M7	MW124R	2,4,-DNT	2.6	NA	0(4)	0.42	<5	<5
M13	MW321	2,4,-DNT	63.1	NA	7.30E-02	0.42	<450	<1200

General Notes:

1,3,5-TNB = 1,3,5-Trinitrobenzene

RDX = Royal Demolition Explosive (Hexahydro 1,3,5-Trinitro-1,3,5-Triazine)

2,4-DNT = 2,4-Dinitrotoluene

Footnotes:

(1) An initial concentration of 347 ug/L for RDX at Site L1 was used during the Remedial Design/Remedial Action BIOSCREEN Model. The actual value reported was 357 ug/L for RDX.

(2) An initial concentration of 32.6 ug/L for RDX during July 1998 was used for the Remedial Design/Remedial Action BIOSCREEN Model for Site L3.

(3) NA = Not Available

(4) First order decay rate constant determination analysis indicated an increasing trend of 2,4-DNT at well MW124R. No decay rate constant could be estimated at well MW124R.

Table 7-1

Summary of Long-Term Monitoring Groundwater Flow Velocities
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Site	Fall 2003 Velocity (ft/day)	Fall 2002 Velocity (ft/day)	Fall 2001 Velocity (ft/day)	Fall 2000 Velocity (ft/day)	Fall 1999 Velocity (ft/day)
L1	0.0007	0.0007	0.0011	0.0006	0.0006
L2	0.2479	0.2312	0.3140	0.2660	0.2222
L3*	0.3643	0.3250	0.3622	0.3612	0.3673
L14*	0.1164	0.1270	0.1132	0.1164	0.1194
M1	0.0075	0.0089	0.0052	0.0078	0.0109
M3	NA	NA	NA	NA	NA
M5	0.0408	0.0272	0.0402	0.3214	0.2619
M6	0.1804	0.1714	0.2194	0.1820	0.1056
M7	0.0734	0.0911	0.0608	0.0747	0.0658
M8	0.0009	0.0025	0.0006	0.0401	0.0324
M13	5.1388	2.4938	4.7646	2.6450	2.7206
	Avg. Vel. (ft/day)	Avg. Vel. (ft/day)	Avg. Vel. (ft/day)	Avg. Vel. (ft/day)	Avg. Vel. (ft/day)
M5, 6, 7, 8, 13	1.3705	1.3105	1.4378	1.9387	1.7101

Note:
1. Hydraulic conductivity values are average values for the overburden aquifer.
2. Horizontal gradients are determined from water table maps using the most recent water table elevation data.

*= No hydraulic conductivity data were available for Site L3 or Site L14. K values are from nearby Site L2.

K = Hydraulic Conductivity

NA = Not Applicable

MDP/mdp/RRJ
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1/29/2004

Table 7-2

Sumamry of Long-Term Monitoring Horizontal Gradients
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Site		October-03 Average Site Gradient	October-02 Average Site Gradient	October-01 Average Site Gradient	October-00 Average Site Gradient	October-99 Average Site Gradient
LAP AREA						
L1	Well Number MW176 MW173 Well Number MW611 MW610	L1 0.0075	L1 0.0078	L1 0.0125	L1 0.0069	L1 0.0074
L2	Well Number MW135 MW404	L2 0.0164	L2 0.0153	L2 0.0208	L2 0.0176	L2 0.0147
L3	Well Number MW1 MW410	L3 0.0237	L3 0.0215	L3 0.0240	L3 0.0239	L3 0.0243
L14	Well Number MW508 MW603	L14 0.0077	L14 0.0084	L14 0.0075	L14 0.0077	L14 0.0079
MANUACTURING AREA						
M1	Well Number MW231 MW351	M1 0.0121	M1 0.0142	M1 0.0083	M1 0.0125	M1 0.0175
M3	(not enough data available)					
M5	Well Number MW127R MW207R	M5 0.0024	M5 0.0016	M5 0.0024	M5 0.0189	M5 0.0154
M6	Well Number MW650 MW165 Well Number MW309 MW160	M6 0.0222	M6 0.0211	M6 0.0270	M6 0.0224	M6 0.0130
M7	Well Number MW307 MW216	M7 0.0116	M7 0.0144	M7 0.0096	M7 0.0118	M7 0.0104
M8	Well Number MW323R MW127R	M8 0.0004	M8 0.0011	M8 0.0003	M8 0.0177	M8 0.0143
M13	Well Number AEHA14R MW350	M13 0.0068	M13 0.0033	M13 0.0063	M13 0.0035	M13 0.0036
M5,6,7,8,13	* The average horizontal gradient for Sites M5, M6, M7, M8, and M13=	M5,M6,M7,M8,M13 0.0087	M5,M6,M7,M8,M13 0.0083	M5,6,7,8,13 0.0091	M5,6,7,8,13 0.0147	M5,6,7,8,10,13 0.0129

Table 7-3

Summary of Long-Term Monitoring Vertical Gradients
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammuntion Plant
Wilmington, Illinois

Site	Area/Well ID	Oct-03 Vertical Gradient (ft/ft)	Oct-02 Vertical Gradient (ft/ft)	Oct-01 Vertical Gradient (ft/ft)	Oct-00 Vertical Gradient (ft/ft)	Oct-99 Vertical Gradient (ft/ft)
LAP AREA						
L1	MW178 MW176	-0.7053	-0.8321	-0.3685	-0.6053	-0.8112
	MW172 MW173	0.0059	0.0025	0.0044	0.0069	0.0025
	MW177 MW171	-0.0485	-0.1522	0.0511	0.1684	-0.1684
	MW401 MW610	0.0218	0.0382	0.0176	0.0213	0.0185
L2	MW621 MW620	0.0012	-0.0022	0.1353	0.0000	-0.0013
L3	MW631 MW630	0.0744	0.0343	0.0696	0.0505	0.0309
L14	MW602 H-7	-0.0879	-0.1024	-0.1132	-0.0882	-0.0452
	MW604 MW603	0.0231	0.0150	0.0011	0.0191	0.0261
MANUFACTURING AREA						
M1	MW640 MW351	0.0237	-0.0237	-0.0179	0.0194	0.0083
	MW642 MW641	-0.0183	-0.0224	-0.0171	-0.0173	-0.0140
M6	MW166R MW320R	0.0007	NM	NM	NM	-0.9059
	MW312 MW311	0.0002	0.0000	NM	NM	0.0000
	MW651 MW650	-0.2678	-0.2334	-0.4149	-0.1693	-0.1789
	MW319 MW318	0.0003	-0.0011	-0.0010	-0.0010	-0.0333
	MW313 MW654 MW164	-0.0059	-0.1148	-0.0556	-0.0166	-0.0398
	MW653 MW652	-0.2208	-0.2011	-0.1774	-0.1684	0.0114
	MW317 MW316	-0.0086	-0.0090	-0.0134	-0.0107	-0.0155

MDP/mdp/RRJ/MGC
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1/30/2004

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Table 7-3

Summary of Long-Term Monitoring Vertical Gradients
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammuntion Plant
Wilmington, Illinois

Site	Area/Well ID	Oct-03 Vertical Gradient (ft/ft)	Oct-02 Vertical Gradient (ft/ft)	Oct-01 Vertical Gradient (ft/ft)	Oct-00 Vertical Gradient (ft/ft)	Oct-99 Vertical Gradient (ft/ft)
M6	MW310R MW309	-0.2875	-0.2140	-0.2597	-0.2545	0.3134
	MW315 MW314	0.0006	-0.0224	-0.0058	-0.0063	-0.0327
	MW308 MW307	-0.2607	-0.3198	-0.2094	-0.2483	-0.3130
M7	MW217 MW216	0.0877	0.3153	-0.0256	0.1448	0.3351
	MW661 MW660	-0.0005	0.0635	-0.0639	0.0097	0.0837
	MW158 MW157	0.3438	NM	0.0092	-0.0510	-0.0322
M13	MW322 MW321	-0.1273	-0.1827	0.0062	NM	-0.2053

Notes:

1. $\text{Vertical Gradient} = \dfrac{\text{Water Level in Deep Well - Water Level in Shallow Well}}{\text{Absolute Value of Water Table Elevation - Screen Midpoint of Deep Well}}$

2. Negative vertical gradients indicate downward flow, positive indicates upward flow.
3. NM = Not measured

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Table 7-4
Summary of Explosive Compound Results - October 2003
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	HMX		RDX		1,3,5-TNB		Tetryl		NB		2,4,6-TNT		2,4-DNT		2,6-DNT		2-A-4,6-DNT		4-A-2,6-DNT		2-NT		3-NT		4-NT		1,3-DNB	
		Units	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
		Risk Based RG	5100		2.6		5.1		200		51		9.5		0.42		0.42		NS		NS		5100		NS		NS		10	
		Surface Water RG	260		500		15		NS		8000		75		330		150		NS		NS		62		NS		NS		NS	
Site	Well	Date	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF
L1	MW131	10/23/2003	<8 5		<4.2		**1100**		<8.5		<4.2		**840**		<4.2 (0.46)		<8.5 (2.2)		29		27		<8.5		<8.5		<8.5		<4.2	
	MW172	10/23/2003	<0 78		1 8		0.52		<0.78		<0 39		3		<0.39 (0.042)		<0.78 (0 21)		1.3		1.7		<0 78		<0.78		<0.78		<0.39	
	MW173	10/23/2003	1.9		**17**		3.2		<0.98		<0 49		**23**		<0.49 (0.052)		<0.98 (0.26)		6.3		6.7		<0.98		<0.98		<0.98		<0.49	
	Dup	10/23/2003	1 8		**15**		3		<0 78		<0.39		**21**		<0.39 (0.042)		<0.78 (0.21)		6.1		6 5		<0.78		<0.78		<0 78		<0.39	
	MW174	10/23/2003	<0.78		<0 39		<0.39		<0.78		<0.39		<0.39		<0 39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW401	10/23/2003	<0.78		<0.39		<0.39		<0.78		<0 39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0 78		<0.78		<0 39	
	MW610	10/23/2003	<0.83		<0.42		<0.42		<0 83		<0.42		<0.42		<0.42 (0.045)		<0.83 (0 22)		<0.83		<0 83		<0.83		<0.83		<0.83		<0 42	
	SW550	10/9/2003	<0.91		<0 46		<0 46		<0 91		<0.46		<0.46		<0 46 (0.049)		<0.91 (0.24)		<0.91		<0.91		<0.91		<0.91		<0 91		<0.46	
	WES1	10/23/2003	<7 8		<3 9		**12**		<7.8		<3 9		**27**		<3.9 (0.42)		<7.8 (2.1)		18		17		<7 8		<7.8		<7.8		<3.9	
	WES3	10/23/2003	<0.78		1 3		1		<0 78		<0 39		2.6		<0.39 (0.042)		<0.78 (0 21)		1.4		1.8		<0.78		<0.78		<0.78		<0.39	
L2	MW133	10/24/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0 21)		<0.78		<0 78		<0.78		<0.78		<0.78		<0.39	
	MW404	10/24/2003	79		**320**		<0.39		<0 78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0 39	
	MW405	10/23/2003	<0 78		<0.39		<0.39		<0.78		<0 39		<0 39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW406	10/24/2003	<0 85		<0.42		<0.42		<0.85		<0 42		<0.42		<0.42 (0.046)		<0.85 (0 22)		<0.85		<0.85		<0.85		<0.85		<0.85		<0.42	
	MW407	10/24/2003	<0.78		<0.39		<0 39		<0 78		<0 39		<0.39		<0.39 (0 042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW620	10/27/2003	<0 78		<0 39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0 78		<0.78		<0.39	
	Dup	10/27/2003	<0.78		<0 39		<0.39		<0 78		<0 39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0 78		<0.78		<0 78		<0 39	
	MW621	10/24/2003	<0.78		<0 39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0 78		<0.78		<0.39	
	SW555	10/10/2003	<0.91		<0.46		<0.46		<0.91		<0.46		<0 46		<0.46 (0.049)		<0.91 (0.24)		<0.91		<0.91		<0.91		<0.91		<0.91		<0 46	
L3	MW410	10/27/2003	<0 81		0.57		<0.4		<0.81		<0.4		<0.4		<0.4 (0.043)		<0.81 (0.21)		<0.81		<0.81		<0.81		<0.81		<0 81		<0 4	
	Dup	10/27/2003	<0.78		0 63		<0.39		<0 78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW412	10/28/2003	11		**58**		<0.42		<0.85		<0 42		<0.42		<0.42 (0.046)		<0.85 (0.22)		<0.85		<0.85		<0.85		<0.85		<0.85		<0.42	
	MW630	10/28/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0 042)		<0.78 (0.21)		<0.78		<0 78		<0.78		<0.78		<0.78		<0.39	
	MW631	10/28/2003	<0 78		<0.39		<0 39		<0 78		<0 39		<0.39		<0 39 (0.042)		<0.78 (0 21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW633	10/27/2003	3.3		**9.8**		<0 39		<0 78		<0.39		<0 39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0 78		<0 78		<0.39	
	SW557	10/10/2003	<0.87		1.4		<0.44		<0 87		<0.44		<0.44		<0.44 (0.047)		<0.87 (0.23)		<0.87		<0.87		<0.87		<0.87		<0.87		<0 44	
	SW777	10/10/2003	<0.83		<0 42		<0 42		<0.83		<0 42		<0.42		<0.42 (0.045)		<0.83 (0.22)		<0.83		<0 83		<0.83		<0.83		<0.83		<0.42	
L14	H7	10/22/2003	<0.78		0.63		<0.39		<0.78		<0.39		<0.39		<0.39 (0 042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW508	10/22/2003	45		**110**		<0 39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0 78		<0.39	
	MW511	10/22/2003	17		**160**		<0 49		<0.98		<0.49		<0.49		<0.49 (0.052)		<0.98 (0 26)		<0.98		<0.98		<0.98		<0.98		<0.98		<0.49	
	MW512	10/22/2003	86		**210**		<0.52		<1		<0.52		<0.52		<0.52 (0.056)		<1 (0.28)		2.1		3.1		<1		<1		<1		<0.52	
	MW600	10/23/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0 042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW601	10/22/2003	<0.78		<0.39		<0 39		<0.78		<0.39		<0 39		<0.39 (0 042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW602	10/22/2003	<0 78		<0 39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0 21)		<0.78		<0.78		<0.78		<0.78		<0 78		<0.39	
	MW603	10/23/2003	<0.78		<0 39		<0.39		<0.78		<0.39		<0 39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW604	10/23/2003	<0 78		<0 39		<0.39		<0.78		<0.39		<0.39		<0.39 (0 042)		<0.78 (0 21)		<0 78		<0.78		<0.78		<0.78		<0.78		<0.39	
M5	MW114R	10/21/2003	<0 78		<0.39		<0 39		<0.78		<0 39		<0.39		<0.39 (0 042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW207R	10/21/2003	<0 78		**4.9**		0.73		<0 78		<0 39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0 78		1		<0.78		0.83		<0.39	
	Dup	10/21/2003	<0.78		<0 39		0 51		<0.78		<0 39		<0.39		**0.79**	/ J	<0.78 (0.21)		<0.78		<0.78		1.1		<0.78		0 91		<0.39	
	MW354R	10/21/2003	<0.78		<0 39		<0.39		<0.78		<0 39		<0.39		<0 39 (0.042)		<0.78 (0 21)		<0.78		<0.78		<0.78		<0 78		<0.78		<0.39	
	MW355R	10/21/2003	<0 83		<0 42		<0.42		<0.83		<0.42		<0.42		<0.42 (0.045)		<0 83 (0.22)		<0.83		<0.83		<0.83		<0 83		<0.83		<0 42	
	SWTET	10/8/2003	<0.78		<0 39		<0 39		<0.78		<0 39		<0.39		<0.39 (0.042)		<0.78 (0 21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
M6	MW116	10/15/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0 39		<0.39 (0.042)		<0 78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW117	10/15/2003	<1 1		<0 53		<0 53		<1.1		<0.53		<0 53		<0.53 (0.057)		<1.1 (0.28)		<1.1		<1 1		<1.1		<1.1		<1.1		<0.53	
	MW118	10/16/2003	<1		<0 51		<0 51		<1		<0.51		<0.51		<0.51 (0.055)		<1 (0 27)		<1		<1		<1		<1		<1		<0.51	
	MW119	10/16/2003	<0.78		<0 39		<0 39		<0 78		<0.39		<0.39		<0 39 (0.042)		<0.78 (0.21)		<0.78		<0 78		<0.78		<0.78		<0.78		<0.39	
	MW123R	10/14/2003	<0.78		<0 39		<0.39		<0 78		<0.39		<0 39		<0 39 (0 042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0 78		<0.39	
	MW160	10/16/2003	<0 78		<0 39		<0 39		<0 78		<0 39		<0.39		<0.39 (0 042)		<0.78 (0.21)		<0 78		<0.78		<0 78		<0 78		<0.78		<0 39	
	MW162R	10/15/2003	<1.1		<0 54		<0 54		<1 1		<0 54		<0.54		<0.54 (0 058)		<1.1 (0.29)		<1 1		<1.1		<1 1		<1.1		<1.1		<0.54	
	MW166R	10/14/2003	<0 78		<0.39		<0 39		<0.78		<0.39		<0 39		<0.39 (0.042)		<0.78 (0 21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0 39	
	MW210R	10/16/2003	<0 83		<0 42		<0 42		<0.83		<0 42		6		**1.8**		**6.3**		12		21		<0.83		<0.83		<0.83		<0.42	
	MW212R	10/17/2003	<7 8		<3.9		<3 9		<7 8		12		**400**		**4400**		**1500**		100		98		**14000**		1200		8400		<3.9	
	MW213R	10/17/2003	<0 78		<0.39		<0.39		<0 78		<0 39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW215R	10/16/2003	<0 78		<0.39		<0 39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW307	10/16/2003	<1		<0.52		<0.52		<1		<0.52		**10**		<0.52 (0.056)		**1.2**		5.7		33		<1		<1		<1		<0 52	
M6	MW308	10/20/2003	<0.78		<0 39		<0.39		<0.78		<0.39		3.4		<0.39 (0.042)		<0.78 (0.21)		3.1		9.6		<0.78		<0.78		<0 78		<0.39	
	MW309	10/17/2003	<0.78		<0 39		<0.39		<0.78		<0.39		2.5		<0.39 (0 042)		**0.8**		5.2		6.9		<0.78		<0.78		<0.78		<0.39	

Table 7-4
Summary of Explosive Compound Results - October 2003
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	HMX		RDX		1,3,5-TNB		Tetryl		NB		2,4,6-TNT		2,4-DNT		2,6-DNT		2-A-4,6-DNT		4-A-2,6-DNT		2-NT		3-NT		4-NT		1,3-DNB	
		Units	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
		Risk Based RG	5100		2.6		5.1		200		51		9.5		0.42		0.42		NS		NS		5100		NS		NS		10	
		Surface Water RG	260		500		15		NS		8000		75		330		150		NS		NS		62		NS		NS		NS	
Site	Well	Date	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF
M6	MW310R	10/17/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW311	10/14/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW312	10/14/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW313	10/17/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW314	10/16/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		1.5		2.3		<0.78		<0.78		<0.78		<0.39	
	MW315	10/16/2003	<1.2		<0.62		<0.62		<1.2		<0.62		4.4		**1.2**		<1.2 (0.33)		41		34		<1.2		<1.2		<1.2		<0.62	
	MW316	10/14/2003	<0.81		<0.4		<0.4		<0.81		<0.4		<0.4		<0.4 (0.043)		<0.81 (0.21)		<0.81		<0.81		<0.81		<0.81		<0.81		<0.4	
	MW317	10/14/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW318	10/14/2003	6.1		<0.46		<0.46		<0.91		<0.46		<0.46		<0.46 (0.049)		<0.91 (0.24)		<0.91		<0.91		<0.91		<0.91		<0.91		<0.46	
	MW319	10/14/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW320R	10/13/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW650	10/15/2003	<0.86		<0.43		<0.43		<0.86		4		**26**		**26**		**100**		75		50		220		9		40		<0.43	
	Dup	10/15/2003	<0.88		<0.44		<0.44		<0.88		3.9		**27**		**28**		**100**		77		51		220		8.8		39		<0.44	
	MW651	10/15/2003	<0.88		<0.44		<0.44		<0.88		<0.44		<0.44		**0.62**		<0.88 (0.23)		<0.88		<0.88		<0.88		<0.88		<0.88		<0.44	
	MW652	10/17/2003	<7.9		<4		<4		<7.9		19		**1300**		**4900**		**2000**		130		72		**19000**		1600		13000		7.1	
	Dup	10/17/2003	<9.1		<4.6		<4.6		<9.1		22		**1500**		**5600**		**2300**		150		86		**23000**		1800		14000		8.3	
	MW653	10/20/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		**1**	/ J	<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW654	10/20/2003	<0.78		0.55		<0.39		<0.78		<0.39		<0.39		**1.7**	/ J	**1.1**		1.7		2.1		2		<0.78		2.2		<0.39	
	MW655	10/16/2003	<0.98		<0.49		<0.49		<0.98		<0.49		<0.49		**0.52**		<0.98 (0.26)		<0.98		<0.98		<0.98		<0.98		<0.98		<0.49	
	SWTNT	10/8/2003	<0.96		<0.48		<0.48		<0.96		<0.48		<0.48		<0.48 (0.052)		<0.96 (0.26)		<0.96		<0.96		<0.96		<0.96		<0.96		<0.48	
	Dup	10/8/2003	<1		<0.51		<0.51		<1		<0.51		<0.51		<0.51 (0.055)		<1 (0.27)		<1		<1		<1		<1		<1		<0.51	
M7	MW112	10/14/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW113	10/14/2003	<0.88		<0.44		<0.44		<0.88		<0.44		<0.44		<0.44 (0.048)		<0.88 (0.23)		<0.88		<0.88		<0.88		<0.88		<0.88		<0.44	
	MW115	10/15/2003	<0.96		<0.48		<0.48		<0.96		<0.48		<0.48		<0.48 (0.052)		<0.96 (0.26)		<0.96		<0.96		<0.96		<0.96		<0.96		<0.48	
	MW124R	10/15/2003	1.3		**6.5**		**6.3**		<0.78		<0.39		**120**		**2.9**		<0.78 (0.21)		55		66		<0.78		<0.78		<7.8		<0.39	
	Dup	10/15/2003	<1.1		**6.4**		**6.8**		<1.1		<0.55		**160**		**3.3**		**1.7**		56		66		<1.1		<1.1		<1.1		<0.55	
	MW157	10/16/2003	<0.9		<0.45		<0.45		<0.9		<0.45		<0.45		<0.45 (0.048)		<0.9 (0.24)		<0.9		<0.9		<0.9		<0.9		<0.9		<0.45	
	MW158	10/16/2003	<0.85		<0.42		<0.42		<0.85		<0.42		<0.42		<0.42 (0.046)		<0.85 (0.22)		<0.85		<0.85		<0.85		<0.85		<0.85		<0.42	
	MW159	10/20/2003	<0.82		<0.41		<0.41		<0.82		<0.41		<0.41		<0.41 (0.044)		<0.82 (0.22)		<0.82		<0.82		<0.82		<0.82		<0.82		<0.41	
	MW216	10/15/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW217	10/15/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW660	10/16/2003	<0.94		<0.47		<0.47		<0.94		<0.47		<0.47		**0.88**		<0.94 (0.25)		<0.94		<0.94		<0.94		<0.94		<0.94		<0.47	
	MW661	10/15/2003	<0.92		<0.46		<0.46		<0.92		<0.46		<0.46		**0.48**		<0.92 (0.24)		<0.92		<0.92		<0.92		<0.92		<0.92		<0.46	
M8	MW147R	10/21/2003	<0.81		<0.4		<0.4		<0.81		<0.4		<0.4		<0.4 (0.043)		<0.81 (0.21)		<0.81		<0.81		<0.81		<0.81		<0.81		<0.4	
	MW148RR	10/21/2003	<0.96		<0.48		<0.48		<0.96		<0.48		<0.48		<0.48 (0.052)		<0.96 (0.26)		<0.96		<0.96		<0.96		<0.96		<0.96		<0.48	
	Dup	10/21/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		<0.78		<0.78		<0.78		<0.78		<0.78		<0.39	
	MW325R	10/13/2003	<0.78		<0.39		<0.39		<0.78		<0.39		<0.39		<0.39 (0.042)		<0.78 (0.21)		3.3		3.8		<0.78		<0.78		<0.78		<0.39	
M13	MW321	10/16/2003	<0.78		<0.39		<0.39		<0.78		<0.39		0.81		**49**		**21**		12		7.6		<0.78		<0.78		2		<0.39	
	Dup	10/16/2003	<0.78		<0.39		<0.39		<0.78		<0.39		1		**47**		**22**		12		8.5		<0.78		<0.78		2.5		<0.39	
	MW322	10/17/2003	<0.9		<0.45		<0.45		<0.9		<0.45		<0.45		<0.45 (0.048)		<0.9 (0.24)		<0.9		<0.9		3.1	/ J	<0.9		1.2		<0.45	
	MW350	10/16/2003	<1.1		<0.55		<0.55		<1.1		<0.55		2.5		<0.55 (0.059)		<1.1 (0.29)		2.8		3.9		<1.1		<1.1		<1.1		<0.55	

Notes
- Bolded Result = RG Exceedance
- LF/VF = Lab Flag/Validation Flag
- Result shows Lab_Limit for non-detected results
- < = Not Detected
- NS = No Standard
- J = Estimated Concentration
- () = MDL for nondetect values

Table Generation Date 12/22/2003 4:30:00 PM
STL-EDD/AAG/

Table 7-5
Summary of Indicator Parameter Results - October 2003
Firts Five-Year Rveiew Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	o-Phos		Alkalinity		Ammonia		Nitrite		Nitrate		Sulfate (SO4)		Sulfide		TKN		TOC		Iron		Dissolved Iron		Manganese	
		Units	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		ug/L		ug/L		ug/L	
		Risk Based RG	NS		NS		NS		NS		NS		400		NS		NS		NS		5000		5000		150	
		Surface Water RG	NS		NS		NS		NS		NS		500		NS		NS		NS		NS		NS		NS	
Site	Well	Date	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF
L1	MW131	10/23/2003	<0.05		490		NA		<0.02		51		37		<1		7.6		15		<50		<50		4.3	J /
	MW172	10/23/2003	<0.05		430		NA		<0.02		4.4		61		3.2		0.11	J /	1.6		<50		<50		<10	
	MW173	10/23/2003	<0.05		400		NA		<0.02		2.4		56		<1		0.32		1.8		<50		<50		<10	
	Dup	10/23/2003	<0.05		440		NA		<0.02		2.8		63		<1		0.11	J /	1.6		<50		<50		1.3	J /
	MW174	10/23/2003	<0.05		420		NA		<0.02		0.11		58		<1		0.26		1.5		<50		<50		4.3	J /
	MW401	10/23/2003	<0.05		400		NA		<0.02		<0.1		72		<1		0.37		1.4		1400		830		25	
	MW610	10/23/2003	<0.05		370		NA		<0.02		0.052	J /	52		<1		0.26		2.3		<50		<50		95	
	WES1	10/23/2003	<0.05		310		<0.2		0.006	J /	4		58	/ J	<1		0.26		2.3		<50		<50		17	
	WES3	10/23/2003	<0.05		400		NA		<0.02		3.5		67		4.2		0.3		1.3		<50		<50		3.6	J /
L2	MW133	10/24/2003	<0.05		370		0.22		<0.02		0.054	J /	43	/ J	<1		0.63		1.1		580		310		18	
	MW404	10/24/2003	<0.05		330		0.19	J /	<0.02		0.047	J /	37	/ J	<1		0.17	J /	2		<50		<50		6.2	J /
	MW405	10/23/2003	<0.05		300		0.22		<0.02		0.035	J /	51	/ J	<1		0.24		1.4		1200		840		56	
	MW406	10/24/2003	<0.05		360		0.15	J /	<0.02		<0.1		39	/ J	<1		0.19	J /	1.4		2000		1800		45	
	MW407	10/24/2003	<0.05		380		0.14	J /	<0.02		0.05	J /	19	/ J	<1		0.17	J /	2.5		4500		3600		34	
	MW620	10/27/2003	0.046	J /	330		0.53		<0.02		<0.1		80		0.8	J /	0.72		2.4		1300		1200		590	
	Dup	10/27/2003	<0.05		350		0.57		<0.02		<0.1		83		0.8	J /	0.68		2.3		1400		1200		580	
	MW621	10/24/2003	0.025	J /	410		0.26		<0.02		<0.1		42	/ J	<1		0.53		1.1		<50		<50		170	
L3	MW410	10/27/2003	<0.05		400		0.35		<0.02		0.052	J /	90		<1		0.43		2.4		1700		1400		340	
	Dup	10/27/2003	<0.05		390		<0.2		<0.02		0.077	J /	86		<1		0.34		2.4		1700		1400		330	
	MW412	10/28/2003	<0.05		390		0.17	J /	<0.02		1.1		100		1.3		0.4		1.8		<50		<50		1	J /
	MW630	10/28/2003	0.026	J /	380		0.23		<0.02		0.15		44		0.6	J /	0.51		1.2		<50		<50		24	
	MW631	10/28/2003	<0.05		380		0.36		<0.02		0.048	J /	41		1		0.54		1.1		100		<50		11	
	MW633	10/27/2003	<0.05		380		<0.2		<0.02		0.53		110		1.4		0.25		2		<50		<50		28	
L14	H7	10/22/2003	<0.05		410		NA		<0.02		0.15		17		<1		0.27		1.8		<50		<50		4.4	J /
	MW508	10/22/2003	<0.05		360		NA		<0.02		0.079	J /	63		<1		0.26		1.7		440		<50		330	
	MW511	10/22/2003	<0.05		360		NA		<0.02		1.6		51		<1		0.25		1.5		230		<50		1	J /
	MW512	10/22/2003	<0.05		300		NA		<0.02		2.7		55		<1		0.24		1.4		<50		<50		4.3	J /
	MW600	10/23/2003	<0.05		340		NA		<0.02		0.049	J /	38		<1		0.27		1.7		130		<50		210	
	MW601	10/22/2003	<0.05		330		NA		<0.02		0.084	J /	69		<1		0.31		1.6		1200		650		100	
	MW602	10/22/2003	<0.05		300		NA		<0.02		<0.1		50		<1		0.25		1.3		1100		950		36	
	MW603	10/23/2003	<0.05		310		NA		<0.02		0.049	J /	44		<1		0.2	J /	1.6		270		170		260	
	MW604	10/23/2003	<0.05		310		NA		<0.02		0.037	J /	43		<1		0.25		1.3		<50		<50		18	
M1	MW105	10/22/2003	<0.05		370		0.14	J /	<0.02		<0.1	U / R	84	/ J	<1		0.35		1.3		<50		<100		36	
	MW106	10/21/2003	<0.05		410		0.52		0.017	J /	<0.1	U / R	73	/ J	<1		0.67		1.4		420		370		100	
	MW107	10/21/2003	0.6		12000		44		0.0091	J /	13	/ R	38000	/ J	5.6		75		100		370		660		14	J /
	Dup	10/21/2003	0.61		11000		46		0.0094	J /	12	/ R	35000	/ J	6.5		100		41		250	J /	380		5.6	J /
	MW201	10/22/2003	0.37		160		0.34		<0.02		<0.1	U / R	10	/ J	2.6		1.3		14		90		<50		52	
	MW231	10/22/2003	0.54		7900		9		0.0082	J /	8.6	/ R	30000	/ J	<5		28		68		630		440		7	J /
	MW347	10/22/2003	<0.05		390		<0.2		<0.02		0.05	J / R	350	/ J	<1		0.44		1.3		1300		950		360	
	MW351	10/20/2003	0.26		430		1.7		<0.02		<0.1		78		1	/ J	2.5		5.4		480		92		71	
	MW640	10/22/2003	<0.05		510		1.1		<0.02		0.042	J / R	2100	/ J	0.6	J /	3.5		6.5		2400		2400		36	
	MW641	10/22/2003	<0.05		550		<0.2		<0.02		0.048	J / R	1100	/ J	2.3		0.95		4.2		1700		1500		100	
	MW642	10/22/2003	0.045	J /	510		0.11	J /	<0.02		<0.1	U / R	640	/ J	<1		0.66		3.1		610		<50		260	
	MW643	10/20/2003	<0.05		430		<0.2		<0.02		<0.1		180		<1		0.62		3.8		950		850		310	
	MW644	10/20/2003	<0.05		350		0.13	J /	<0.02		0.2		330		<1		0.42		2.3		<50		<100		3.8	J /

Table 7-5
Summary of Indicator Parameter Results - October 2003
Firts Five-Year Rveiew Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	o-Phos		Alkalinity		Ammonia		Nitrite		Nitrate		Sulfate (SO4)		Sulfide		TKN		TOC		Iron		Dissolved Iron		Manganese	
		Units	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		ug/L		ug/L		ug/L	
		Risk Based RG	NS		NS		NS		NS		NS		400		NS		NS		NS		5000		5000		150	
		Surface Water RG	NS		NS		NS		NS		NS		500		NS		NS		NS		NS		NS		NS	
Site	Well	Date	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF
M1	MW645	10/20/2003	<0.05		380		<0.2		<0.02		0.15		240		<1		0.33		2		<250		<250		1.8	J /
	MW646	10/20/2003	<0.05		260		<0.2		<0.02		0.18		240		<1		0.43		2.1		<50		<250		3.7	J /
	MW647	10/21/2003	<0.05		300		0.28		<0.02		0.25	/ R	320	/ J	1.4		0.66		1.1		<250		<250		4	J /
	MW648	10/20/2003	<0.05		310		<0.2		<0.02		0.072	J /	34		<1		0.41		1		190		<50		10	
	MW649	10/22/2003	<0.05		340		0.17	J /	<0.02		0.14	/ R	510	/ J	<1		0.22		1.5		<50		<250		8	J /
	Dup	10/22/2003	<0.05		360		0.19	J /	<0.02		0.27	/ R	500	/ J	0.9	J /	0.22		1.5		<50		<250		5.8	J /
	SW701	10/9/2003	NA		NA		NA		NA		NA		160		NA		NA		NA		NA		NA		NA	
	Dup	10/9/2003	NA		NA		NA		NA		NA		160		NA		NA		NA		NA		NA		NA	
	SW702	10/9/2003	NA		NA		NA		NA		NA		190		NA		NA		NA		NA		NA		NA	
	SW704	10/9/2003	NA		NA		NA		NA		NA		100		NA		NA		NA		NA		NA		NA	
	SW705	10/9/2003	NA		NA		NA		NA		NA		100		NA		NA		NA		NA		NA		NA	
	SW706	10/9/2003	NA		NA		NA		NA		NA		130		NA		NA		NA		NA		NA		NA	
	SW707	10/9/2003	NA		NA		NA		NA		NA		110		NA		NA		NA		NA		NA		NA	
	SW708	10/9/2003	NA		NA		NA		NA		NA		120		NA		NA		NA		NA		NA		NA	
M5	MW114R	10/21/2003	<0.05		290		0.23		<0.02		0.11		65		<1		0.34		1.4		1200		1000		86	
	MW207R	10/21/2003	<0.05		320		0.28		<0.02		0.12		170		<1		0.53		2.2		530		470		100	
	Dup	10/21/2003	<0.05		320		0.34		<0.02		0.041	J /	200		<1		0.33		2		500		480		99	
	MW354R	10/21/2003	<0.05		290		0.36		<0.02		0.083	J /	250		<1		0.52		2.2		1500		1300		280	
	MW355R	10/21/2003	<0.05		310		<0.2		<0.02		0.072	J /	300		<1		0.47		2		2700		2300		300	
M6	MW116	10/15/2003	<0.05		360		<0.2		<0.02		0.11		110		<1		0.29		1.4		<50		<50		30	
	MW117	10/15/2003	<0.05		360		0.23		<0.02		0.062	J /	210		3.1		0.53		4.4		1400		1300		88	
	MW118	10/16/2003	<0.05		310		<0.2		<0.02		0.21		75		<1		0.43		2.4		<50		<50		0.8	J /
	MW119	10/16/2003	0.039	J /	330		0.11	J /	<0.02		0.11		160		<1		0.41		2.7		1300		<50		150	
	MW123R	10/14/2003	<0.05		490		0.38		<0.02		0.088	J /	250		<1		0.6		4.1		3100		3200		190	
	MW160	10/16/2003	<0.05		480		0.26		<0.02		<0.1		56		4.8		0.73		4.9		510		390		880	
	MW162R	10/15/2003	<0.05		600		0.21		<0.02		0.083	J /	200		<1		0.56		6.4	/ B	1800		1800		1000	
	MW166R	10/14/2003	0.3		310		0.37	/ B	<0.02		0.083	J / JB	460		<1		0.52		1.2	/ B	1000	/ J	980		97	
	MW210R	10/16/2003	<0.05		350		0.22		0.0088	J /	7.9		71		2.8		0.7		2.7		<50		<50		7.3	J /
	MW210R	10/17/2003	NA		NA		NA		NA		NA		NA		NA		NA		NA		<50		<50		240	
	MW212R	10/17/2003	<0.05		350		0.71		0.039		0.23		170		1.7		1.1		15		NA		NA		NA	
	MW213R	10/17/2003	<0.05		270		0.67		<0.02		<0.1		190		<1		0.79		1.2		430		<50		83	
	MW215R	10/16/2003	<0.05		290		<0.2		<0.02		1.1		100		<1		0.47		1		<50		<50		1.3	J /
	MW307	10/16/2003	0.053		250		0.12	J /	<0.02		3.9		64		<1		0.3		1.4		<100		<50		4.6	J /
	MW308	10/20/2003	0.037	J /	260		0.24		0.13		1.8		190		<1		0.44		1.5		510		<250		29	
	MW309	10/17/2003	<0.05		340		0.13	J /	<0.02		2.4		35		<1		0.43		1.3		<50		<50		1.2	J /
	MW310R	10/17/2003	0.03	J /	280		0.39		<0.02		0.058	J /	38		<1		0.48		0.87	J /	79		<50		47	
	MW311	10/14/2003	<0.05		340		0.56	/ B	<0.02		0.068	J / JB	160		<1		0.72		1.1	/ B	<50	U / UJ	<50		120	
	MW312	10/14/2003	<0.05		330		0.54		<0.02		<0.1		170		<1		0.68		1.1		<50		58		15	
	MW313	10/17/2003	0.029	J /	180		1.2		0.0074	J /	<0.1		180		<1		2.5		4.9		670		370		480	
	MW314	10/16/2003	<0.05		400		<0.2		<0.02		0.59		250		<1		0.2	J /	2.3		<250		<50		5.5	J /
	MW315	10/16/2003	<0.05		380		<0.2		<0.02		0.059	J /	180		<1		0.3		2.9		<50		<50		130	
	MW316	10/14/2003	0.046	J /	370		1.1		<0.02		<0.1		130		4.4		2.6		5.6		<50	U / UJ	<50		25	
	MW317	10/14/2003	0.042	J /	350		0.52		0.0063	J / J	<0.1		170		1.2		1.2		3.7		860		920		340	
	MW318	10/14/2003	0.031	J /	410		1.2		<0.02		<0.1		240		4.6		3.2		12		1100	/ J	990		110	
	MW319	10/14/2003	0.042	J /	440		2.2		<0.02		<0.1		250		6.2		6		16		<50	U / UJ	<50		45	
	MW320R	10/13/2003	<0.05		360		0.35	/ B	<0.02		<0.1		220		0.6	J /	0.52		1.4	/ B	<50	U / UJ	<100		91	
	MW650	10/15/2003	<0.05		370		0.13	J /	0.016	J /	2.2		120		<1		0.32		1.8		<250		<50		47	
	Dup	10/15/2003	<0.05		360		<0.2		0.018	J /	2.1		140		<1		0.13	J /	1.9		<50		<50		45	

Table 7-5
Summary of Indicator Parameter Results - October 2003
Firts Five-Year Rveiew Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	o-Phos		Alkalinity		Ammonia		Nitrite		Nitrate		Sulfate (SO4)		Sulfide		TKN		TOC		Iron		Dissolved Iron		Manganese	
		Units	MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		MG/L		ug/L		ug/L		ug/L	
		Risk Based RG	NS		NS		NS		NS		NS		400		NS		NS		NS		5000		5000		150	
		Surface Water RG	NS		NS		NS		NS		NS		500		NS		NS		NS		NS		NS		NS	
Site	Well	Date	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF	Result	LF/VF
M6	MW651	10/15/2003	0.026	J /	520		0.29		<0.02		<0.1		360		<1		0.86		4.6		<100		<50		**560**	
	MW652	10/17/2003	<0.05		81		0.64		0.037		1.4		350		<1		1.1		18		<100		<50		**990**	
	Dup	10/17/2003	<0.05		350		0.84		0.038		1.4		340		<1		1.2		18		<100		<50		**1000**	
	MW653	10/20/2003	0.034	J /	300		0.43		<0.02		0.093	J /	120		<1		0.66		1.5		110		<50		100	
	MW654	10/20/2003	0.065		370		0.14	J /	0.1		0.16		170		<1		1.1		3		<50		<250		120	
	MW655	10/16/2003	0.12		420		0.25		<0.02		<0.1		60		<1		0.75		3.2		1100		940		**1300**	
	MW662	10/13/2003	<0.05		340		0.16	J / JB	<0.02		0.1	/ JB	230		<1		0.35		1.7	/ B	530	/ J	540		**300**	
	MW663	10/13/2003	<0.05		360		0.66	/ B	<0.02		0.059	J / JB	140		0.6	J /	1.1		3		380	/ J	330		27	
	MW664	10/14/2003	<0.05		530		0.23		<0.02		3.7	/ B	270		<1		0.37		2.1		**5800**	/ J	<250		**530**	
	MW665	10/13/2003	<0.05		350		0.54	/ B	<0.02		0.17	/ B	210		<1		0.65		1.2	/ B	<50	U / UJ	<50		42	
M7	MW112	10/14/2003	<0.05		410		<0.2		<0.02		<0.1		110		<1		0.37		2.2		<50	U / UJ	<100		16	
	MW113	10/14/2003	<0.05		500		0.11	J /	<0.02		0.048	J /	160		4.3		0.28		1.9	/ B	<50		<50		86	
	MW115	10/15/2003	<0.05		340		0.42		<0.02		0.055	J /	94		<1		0.62		1.7		250		250		120	
	MW124R	10/15/2003	<0.05		290		0.23		0.0099	J /	0.67		170		<1		2.4		14		<50		<50		**250**	
	Dup	10/15/2003	<0.05		300		0.68		0.012	J /	0.6		120		<1		2.5		13		<50		<50		**250**	
	MW157	10/16/2003	<0.05		430		0.21		<0.02		0.12		270		3.5		0.54		4.8		<50		<50		**410**	
	MW158	10/16/2003	<0.05		410		0.15	J /	<0.02		0.082	J /	130		<1		0.73		5.9		260		260		**160**	
	MW159	10/16/2003	NA		NA		NA		NA		NA		NA		NA		NA		1.7		NA		NA		NA	
	MW159	10/22/2003	<0.05		220		0.46		0.009	J /	0.3	/ R	**1100**	/ J	NA		1.3		NA		NA		NA		NA	
	MW159	10/24/2003	NA		NA		NA		NA		NA		NA		4.5		NA		NA		NA		1500		**330**	
	MW159	10/28/2003	NA		NA		NA		NA		NA		NA		NA		NA		NA		3100		NA		NA	
	MW216	10/15/2003	<0.05		540		0.44		<0.02		0.11		290		0.7	J /	0.95		3.3		570		580		100	
	MW217	10/15/2003	<0.05		290		0.14	J /	0.0053	J /	0.45		170		3.4		1.2		4.6		<50		41	J /	24	
	MW660	10/16/2003	<0.05		490		0.87		<0.02		<0.1		190		0.6	J /	1.3		3.3		670		680		**250**	
	MW661	10/15/2003	0.028	J /	340		0.37		<0.02		<0.1		130		<1		0.53		1.3		<100		<50		51	
M8	MW147R	10/21/2003	0.037	J /	270		0.21		<0.02		<0.1		110		<1		0.37		1.4		100		43	J /	21	
	MW148RR	10/21/2003	0.028	J /	300		0.18	J /	0.018	J /	0.44		**460**		<1		0.27		1.7		<250		<250		**190**	
	Dup	10/21/2003	<0.05		260		0.15	J /	0.019	J /	0.45		**470**		0.7	J /	0.23		1.6		<50		<250		**210**	
	MW323R	10/21/2003	<0.05		410		0.17	J /	<0.02		0.1		2.2	J /	<1		0.27		1.6		140		<50		**940**	
	MW325R	10/13/2003	<0.05		380		0.17	J / JB	<0.02		2.5		**690**		3.7		0.45		2.8	/ B	<250		<250		61	
	MW327R	10/21/2003	<0.05		140		4		0.016	J /	0.096	J /	170		1.8		4.7		9.9		1400		780		140	
	MW330	10/21/2003	<0.05		410		0.18	J /	<0.02		0.043	J / R	**500**	/ J	<1		0.38		1.2		**18000**		<250		41	
M13	MW321	10/16/2003	<0.05		400		0.24		<0.02		0.34		64		<1		0.6		2.2		<50		<50		**270**	
	Dup	10/16/2003	<0.05		410		0.27		<0.02		0.35		130		<1		0.55		2.2		<100		<50		**280**	
	MW322	10/17/2003	<0.05		330		<0.2		<0.02		0.22		170		<1		0.11	J /	1.6		<50		<50		<10	
	MW350	10/16/2003	<0.05		430		0.16	J /	<0.02		3.3		260		4		0.29		1.6		<250		<50		<10	

Notes:
- Bolded Result = RG Exceedance
- LF/VF = Lab Flag/Validation Flag
- Result shows Lab_Limit for non-detected results
- NS = No Standard
- NA = Not Analyzed
- < = Not detected
- J = Estimated concentration
- B = Compound detected in Method Blank
- R = Compound rejected during validation
- U = Analyte not detected

STL-EDD/AAG/

Table 7-6
Summary of Volatile Organic Compound Results - October 2003
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	1,1,1-TCA		1,1-DCA		1,2-DCA		1,2-DCE(tot)		MEK		Acetone		Benzene		Carbon disulfide		Chlorobenzene	
		Units	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
		Groundwater Class 1 RG	200		700		5		70		NS		NS		5		NS		100	
		Groundwater Class 2 RG	1000		3500		NS		200		NS		NS		25		NS		NS	
		Surface Water RG	NS		2000		NS		1100		NS		120000		79		NS		NS	
Site	**Well**	**Date**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**	**Result**	**LF/VF**
M6	MW118	10/16/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW119	10/16/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW166R	10/14/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW311	10/14/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW312	10/14/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW320R	10/13/2003	<5		<5		<5		6.8		<5		<5		<5		<5	U / UJ	<5	
	MW650	10/15/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	Dup	10/15/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW651	10/15/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW662	10/13/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW663	10/13/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW664	10/14/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
	MW665	10/13/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	
M8	MW147R	10/21/2003	<5		<5		<5		<5		<5		<5		<5		<5		<5	
	MW148RR	10/21/2003	<5		5.3		<5		<5		<5		<5		<5		<5		<5	
	Dup	10/21/2003	<5		4.4	J /	<5		<5		<5		<5		<5		<5		<5	
	MW323R	10/21/2003	<5		<5		<5		<5		<5		<5		<5		<5		<5	
	MW325R	10/13/2003	<5		<5		<5		<5		<5		<5		<5		<5		<5	
	MW327R	10/21/2003	<5		<5		<5		<5		<5		5.4		<5		<5		<5	
	MW330	10/21/2003	<5		<5		<5		<5		<5		<5		<5		<5	U / UJ	<5	

Notes:
- Bolded Result = RG Exceedance
- LF/VF = Lab Flag/Validation Flag
- Result shows Lab_Limit for non-detected results
- < = Not Detected
- NS = No Standard
- J = Estimated Concentration
- U = Not Detected
- VC = Vinyl Chloride

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Table 7-6
Summary of Volatile Organic Compound Results - October 2003
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

		Compound	Ethyl Benzene		PCE		Toluene		TCE		Xylenes (total)		VC		MethCl	
		Units	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
		Groundwater Class 1 RG	700		5		1000		5		10000		5		NS	
		Groundwater Class 2 RG	NS		25		2500		25		NS		25		NS	
		Surface Water RG	NS		150		650		150		NS		NS		NS	
Site	**Well**	**Date**	**Result**	LF/VF	**Result**	LF/VF	**Result**	LF/VF	**Result**	LF/VF	**Result**	LF/VF	**Result**	LF/VF	**Result**	LF/VF
M6	MW118	10/16/2003	<5		<5		<5		<5		<5		<5		<5	
	MW119	10/16/2003	<5		<5		<5		<5		<5		<5		<5	
	MW166R	10/14/2003	<5		<5		<5		<5		<5		<5		<5	
	MW311	10/14/2003	<5		<5		<5		<5		<5		<5		<5	
	MW312	10/14/2003	<5		<5		<5		<5		<5		<5		<5	
	MW320R	10/13/2003	<5		<5		<5		<5		<5		<5		<5	
	MW650	10/15/2003	<5		<5		<5		<5		<5		<5		<5	
	Dup	10/15/2003	<5		<5		<5		<5		<5		<5		<5	
	MW651	10/15/2003	<5		<5		<5		<5		<5		<5		<5	
	MW662	10/13/2003	<5		<5		<5		<5		<5		<5		<5	
	MW663	10/13/2003	<5		<5		<5		<5		<5		<5		<5	
	MW664	10/14/2003	<5		<5		<5		<5		<5		<5		<5	
	MW665	10/13/2003	<5		<5		<5		<5		<5		<5		<5	
M8	MW147R	10/21/2003	<5		<5		<5		<5		<5		<5		<5	
	MW148RR	10/21/2003	<5		<5		<5		<5		<5		<5		<5	
	Dup	10/21/2003	<5		<5		<5		<5		<5		<5		<5	
	MW323R	10/21/2003	<5		<5		<5		<5		<5		<5		<5	
	MW325R	10/13/2003	<5		<5		<5		<5		<5		<5		<5	
	MW327R	10/21/2003	<5		<5		<5		<5		<5		<5		<5	
	MW330	10/21/2003	<5		<5		<5		<5		<5		<5		<5	

Notes:
- Bolded Result = RG Exceedance
- LF/VF = Lab Flag/Validation Flag
- Result shows Lab_Limit for non-detected results
- < = Not Detected
- NS = No Standard
- J = Estimated Concentration
- U = Not Detected
- VC = Vinyl Chloride

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Table 7-7

Summary of Vertical Gradients - October 2003
First-Five Year Review Report
Groundwater Operable Unit
Joliet Army Ammuniton Plant
Wilmington, Illinois

Site	Area/Well ID	Ground Elevation	Depth (ft) to top of screen (from ground)	Depth (ft) to bottom of screen (from ground)	Screen Length (feet)	Elevation of Screen Midpoint	Water Elevation 10/03	Vertical Gradient (ft/ft)
LAP AREA								
L1	MW178	640.39	27.3	46.5	19.2	603.49	609.27	-0.7053
	MW176	643.49	4.8	20.8	16.0	630.69	623.10	
	MW172	613.19	14.5	34.5	20.0	588.69	605.79	0.0059
	MW173	612.56	2.8	11.8	9.0	605.26	605.69	
	MW177	613.84	11.8	31.0	19.2	592.44	606.77	-0.0485
	MW171	615.03	2.9	7.9	5.0	609.63	607.50	
	MW401	610.2	28.5	43.5	15.0	574.20	605.14	0.0218
	MW610	609.62	4.0	14.0	10.0	600.62	604.48	
L2	MW621	602.41	22.0	32.0	10.0	575.41	599.97	0.0012
	MW620	602.41	7.0	17.0	10.0	590.41	599.94	
L3	MW631	592.23	16.0	26.0	10.0	571.23	589.56	0.0744
	MW630	592.23	7.0	12.0	5.0	582.73	588.29	
L14	MW602	581.22	21.0	31.0	10.0	555.22	573.17	-0.0879
	H-7	581.45	4.0	14.0	10.0	572.45	574.90	
	MW604	578.27	20.0	30.0	10.0	553.27	571.86	0.0231
	MW603	578.27	6.0	16.0	10.0	567.27	571.44	
MANUFACTURING AREA								
M1	MW640	545.4	29.0	39.0	10.0	511.40	542.52	0.0237
	MW351	545.68	9.5	19.5	10.0	531.18	541.80	
	MW642	545.08	29.0	39.0	10.0	511.08	543.28	-0.0183
	MW641	545.08	7.0	17.0	10.0	533.08	543.88	
M6	MW166R	555.6	10.0	20.0	10.0	540.60	543.13	0.0007
	MW320R	554.6	30.5	45.5	15.0	516.00	543.15	
	MW312	545.96	40.0	55.0	15.0	498.46	545.17	0.0002
	MW311	546.36	14.0	24.0	10.0	527.36	545.16	
	MW651	563.83	36.0	46.0	10.0	522.83	546.29	-0.2678
	MW650	563.83	12.0	22.0	10.0	546.83	554.87	
	MW319	545.49	40.0	55.0	15.0	497.99	535.87	-0.0013
	MW318	545.23	11.8	21.8	10.0	528.43	535.86	
	MW313	549.20	25.0	40.0	15.0	516.70	536.86	-0.1336
	MW654	548.49	13.0	23.0	10.0	530.49	536.75	
	MW164	541.69	3.0	6.0	3.0	537.19	536.86	
	MW653	561.93	36.0	46.0	10.0	520.93	546.06	54.7692
	MW652	561.93	11.0	21.0	10.0	545.93	553.18	
	MW317	540.71	34.0	49.0	15.0	499.21	534.75	0.0318
	MW316	540.49	13.0	18.0	5.0	524.99	535.06	

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Table 7-7

Summary of Vertical Gradients - October 2003
First-Five Year Review Report
Groundwater Operable Unit
Joliet Army Ammuniton Plant
Wilmington, Illinois

Site	Area/Well ID	Ground Elevation	Depth (ft) to top of screen (from ground)	Depth (ft) to bottom of screen (from ground)	Screen Length (feet)	Elevation of Screen Midpoint	Water Elevation 10/03	Vertical Gradient (ft/ft)
M6	MW310R	563.00	44.5	59.5	15.0	511.00	541.55	-7.3393
	MW309	563.43	12.7	27.7	15.0	543.23	553.88	
	MW315	538.91	29.7	44.7	15.0	501.71	535.15	0.0371
	MW314	539.53	9.7	14.7	5.0	527.33	535.44	
	MW308	561.38	50.5	65.5	15.0	503.38	533.30	-1.7154
	MW307	561.45	17.0	27.0	10.0	539.45	543.85	
M7	MW217	536.90	19.5	34.5	15.0	509.90	531.23	-0.7748
	MW216	536.51	5.0	10.0	5.0	529.01	529.51	
	MW661	537.09	20.0	30.0	10.0	512.09	531.98	0.0023
	MW660	537.08	7.0	12.0	5.0	527.58	531.99	
	MW158	531.58	9.0	29.5	20.5	512.33	529.02	-0.9283
	MW157	531.37	3.7	10.2	6.5	524.42	524.75	
M13	MW322	542.26	34.5	49.5	15.0	500.26	531.60	0.6374
	MW321	542.93	13.5	23.5	10.0	524.43	536.17	

Notes:

1. Vertical Gradient = $\dfrac{\text{Water Level in Deep Well - Water Level in Shallow Well}}{\text{Water Table Elevation - Screen Midpoint of Deep Well}}$
2. Negative vertical gradients indicate downward flow, positive indicates upward flow.
3. NM = Not measured

Table 7-8

Summary of Horizontal Gradients - October 2003
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Site	October 2003 Groundwater Elevation (ft MSL)	October 2003 Groundwater Elevation (ft MSL)	Head Difference (ft)	Horizontal Separation (ft)	Horizontal Gradient	Average Site Gradient
LAP AREA						
L1	Well Number					
	MW176	MW173			L1 (North)	
	623.10	605.69	17.41	1620	0.0107	
	Well Number					
	MW611	MW610			L1 (South)	**L1**
	606.24	604.48	1.76	420	0.0042	**0.0075**
L2	Well Number					
	MW135	MW404			L2	**L2**
	624.03	599.48	24.55	1500	0.0164	**0.0164**
L3	Well Number					
	MW1	MW410			L3	**L3**
	611.03	592.58	18.45	780	0.0237	**0.0237**
L14	Well Number					
	MW508	MW603			L14	**L14**
	577.42	571.44	5.98	780	0.0077	**0.0077**
MANUACTURING AREA						
M1	Well Number					
	MW231	MW351			M1	**M1**
	545.42	541.80	3.62	300	0.0121	**0.0121**
M3	(not enough data available)					
M5	Well Number					
	MW127R	MW207R			M5	**M5**
	552.41	546.25	6.16	2520	0.0024	**0.0024**
M6	Well Number					
	MW650	MW165			M6 (North)	
	554.87	536.27	18.60	937.5	0.0198	
	Well Number					
	MW309	MW160			M6 (South)	**M6**
	553.88	534.66	19.22	780	0.0246	**0.0222**
M7	Well Number					
	MW307	MW216			M7	**M7**
	543.85	529.51	14.34	1237.5	0.0116	**0.0116**
M8	Well Number					
	MW323R	MW127R			M8	**M8**
	553.89	552.41	1.48	3960	0.0004	**0.0004**
M13	Well Number					
	AEHA14R	MW350			M13	**M13**
	551.27	537.50	13.77	2025	0.0068	**0.0068**
M5,6,7,8,13						**M5,M6,M7,M8,M13**
	*** The average horizontal gradient for sites M5, M6, M7, M8, and M13 =**					**0.0087**

Note:
NA = Not Applicable
1. Gradients measured from water table maps included in this Report.

Table 7-9

Summary of Groundwater Flow Velocities - October 2003
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Site	Average K (cm/sec)	Horizontal Gradient	Effective Porosity	Velocity (cm/sec)	Velocity (ft/day)
L1	9.2E-06	0.0075	0.3	2.3E-07	0.0007
L2	1.6E-03	0.0164	0.3	8.7E-05	0.2479
L3*	1.6E-03	0.0241	0.3	1.3E-04	0.3643
L14*	1.6E-03	0.0077	0.3	4.1E-05	0.1164
M1	6.6E-05	0.0121	0.3	2.7E-06	0.0075
M3	NA	NA	0.3	NA	NA
M5	1.8E-03	0.0024	0.3	1.4E-05	0.0408
M6	8.6E-04	0.0222	0.3	6.4E-05	0.1804
M7	6.7E-04	0.0116	0.3	2.6E-05	0.0734
M8	2.4E-04	0.0004	0.3	3.2E-07	0.0009
M13	8.0E-02	0.0068	0.3	1.8E-03	5.1388
	Avg. K (cm/sec)	Avg. Horiz. Grad.	Eff. Porosity	Avg. Vel. (cm/sec)	Avg. Vel. (ft/day)
M5, 6, 7, 8, 13	1.7E-02	0.0087	0.3	4.8E-04	1.3705

Note:
1. Hydraulic conductivity values are average values for the overburden aquifer.
2. Horizontal gradients are determined from water table maps using the most recent water table elevation data.

*= No hydraulic conductivity data were available for Site L3 or Site L14. K values are from nearby Site L2.

K = Hydraulic Conductivity

NA = Not Applicable

Table 7-10
Summary of Implemented Institutional Controls
First Five-Year Review Report
Groundwater Operable Unit
Joliet Army Ammunition Plant
Wilmington, Illinois

Site	GRU Designation	Access Controls		Institutional Controls		Future Land Use	Current Owner	GMZ Boundary	Frequency of Monitoring
		Fencing	Security Patrols	Deed Restrictions	Annual Certification of Compliance				
L1	GRU1	Yes	Yes	No	na	Prairie	U.S Army	Figure 7-30	Semi-Annual
L2	GRU1	Yes	Yes	No	na	Prairie	U.S Army	Figure 7-33	Semi-Annual
L3	GRU1	Yes	Yes	No	na	Prairie	U.S. Army	Figure 7-36	Semi-Annual
L14	GRU1	Yes	Yes	No	na	Prairie	U.S Army	Figure 7-39	Semi-Annual
M1	GRU2	Yes	Yes	No	na	Prairie	U.S Army	Figure 7-42	Semi-Annual
M3	GRU3	No	Yes	No	na	Prairie	U.S Army	Figure 7-48	None
M5	GRU2	No	No	Yes	Yes	Industrial	Centerpoint	Figure 7-46	Semi-Annual
M6	GRU2	No	Yes	No	na	Industrial	U.S Army	Figure 7-46	Semi-Annual
M7	GRU2	No	Yes	No	na	Industrial	U.S Army	Figure 7-46	Semi-Annual
M8	GRU2	Yes	No	Yes	Yes	Industrial	Centerpoint	Figure 7-46	Semi-Annual
M10	GRU3	No	Yes	No	na	Industrial/Prairie	U.S Army	Figures 3-3 & 3-4	None
M13	GRU2	No	No	Yes	Yes	Industrial	Centerpoint	Figure 7-46	Semi-Annual

Notes:
1. Perimeter fencing surrounds the entire LAP area to prevent unauthorized access to the sites.
2. Only properties that have been transferred by deed, currently have active deed restrictions.
3. A portion of Site M13 has been transferred to the State of Illinois. The parcel of land on Site M13 that has SRU6 soils, remains undeveloped and undisturbed.
4. In all cases the GMZ boundary extends to the base of the Silurian dolomite.

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Figures and Appendices can be obtained from the Site File (s)